

PB 207 151

THE CEMENT INDUSTRY:
Economic Impact of Pollution Control Costs

VOLUME II

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
Springfield, Va. 22151

***The
Boston
Consulting
Group***

ONE BOSTON PLACE • BOSTON • MASSACHUSETTS 02106

THE CEMENT INDUSTRY:
ECONOMIC IMPACT OF POLLUTION CONTROL COSTS

A Report
prepared under

Contract EQC-204
for

THE COUNCIL ON ENVIRONMENTAL QUALITY
and
THE ENVIRONMENTAL PROTECTION AGENCY

by

THE BOSTON CONSULTING GROUP
One Boston Place
Boston, Massachusetts 02106

November 1971

Table of Contents

	<u>Page</u>
Section 1: SUMMARY AND ISSUES	1
POLLUTION CONTROL	1
PUBLIC POLICY AND LEGISLATIVE ISSUES	4
ISSUES OF OPERATING ECONOMICS	5
Section 2: INDUSTRY DESCRIPTION	9
PRODUCTS, MARKETS AND PRODUCERS	9
TYPES OF CEMENT COMPANIES	10
CONCENTRATION OF CEMENT PRODUCERS	10
PLANT SIZE DISTRIBUTION	16
PLANT LOCATION DISTRIBUTION	28
PLANTS BY COMPANIES	32
COMPETITION AND GROWTH	39
MERGERS	42
INTEGRATION	42
DIVERSIFICATION	43
NEW ENTRY INTO THE CEMENT BUSINESS	46
Section 3: PRODUCTION PROCESS AND POLLUTION CONTROL PROBLEMS	49
CEMENT PRODUCTION PROCESSES	49
POLLUTION IN THE CEMENT INDUSTRY	52

LEVEL OF CONTROL AND INDUSTRY IMPACT	59
POLLUTION CONTROL STANDARDS	61
NEW PLANT STANDARDS VERSUS EXISTING PLANT STANDARDS	63
MEASUREMENT METHODS	65
Section 4: MARKET STRUCTURE AND DISTRIBUTION	67
PRODUCT MARKETS	67
GEOGRAPHIC MARKETS	70
APPLICATION MARKETS	74
DISTRIBUTION IMPACT ON MARKETS	80
Section 5: FINANCIAL RESOURCES OF THE CEMENT INDUSTRY	87
PLANT ECONOMICS	88
CAPITAL COSTS AND INVESTMENT PRACTICES	98
FINANCIAL STRUCTURE AND POLICY	110
POLLUTION CONTROL AND FINANCIAL RESOURCES	122
Section 6: CEMENT DEMAND, FOREIGN TRADE AND EMPLOYMENT IMPACT	133
SOURCES OF CEMENT DEMAND	133
POLLUTION COST EFFECTS ON CEMENT DEMAND	137
EMPLOYMENT IN THE CEMENT INDUSTRY	143
Appendix 1: SELECTED INDUSTRY STATISTICS	149
A. Portland Cement Shipments by Types	150
B. Effective Versus Stated Capacity	151

	<u>Page</u>
C. Capacity Growth Versus Demand	152
D. Shipments by Types of Carriers	153
E. Raw Materials for Portland Cement Products	154
<u>Appendix 2:</u> INDUSTRY ESTIMATES OF POLLUTION CONTROL COSTS	155
<u>Appendix 3:</u> ISOMETRIC FLOW CHART OF THE MANUFACTURE OF PORTLAND CEMENT	161
<u>Appendix 4:</u> ANALYSIS OF CAPITAL NEEDS AND RESOURCES	163
<u>Appendix 5:</u> ANALYSIS OF THE ECONOMICS OF A HYPO- THETICAL NEW CEMENT PLANT	177

INDEX TO EXHIBITS

<u>Page Number</u>	<u>Exhibit Number</u>	<u>Title of Exhibits</u>
11	2.1	Uses of Concrete in the U.S.
12	2.2	U.S. Cement Companies in Order of Size - 1969
14	2.3	Composition of Companies by Number of Plants
15	2.4	Capacity Concentration Ratios Con- tinental U.S. Portland Cement
18	2.5	Trends in Size Distribution of Plants, 1950-1970
19	2.6	Type I (Plants with Less than 1 Mil- lion Bbl. Capacity)
20	2.7	Type II (Plants with 1-2 Million Bbl. Capacity)
21	2.8	Type III (Plants with 2-3 Million Bbl. Capacity)
22	2.9	Type IV (Plants with 3-4 Million Bbl. Capacity)
24	2.10	Type V (Plants with 4-5 Million Bbl. Capacity)
25	2.11	Type VI (Plants with 5 Million Bbl. Capacity and Over)
26	2.12	Summary Graph for All Six Plant Types
27	2.13	Trends in Size Distribution of Plants
29	2.14	Future Estimates of Plant Size Dis- tribution (Number of Plants)
30	2.15	Potential Capacity Requirements (Million Barrels)

INDEX TO EXHIBITS (Con't.)

<u>Page Number</u>	<u>Exhibit Number</u>	<u>Title of Exhibits</u>
31	2.16	1970 Geographical Plant Size Distribution
33	2.17	Plant Size Distribution in Ten Largest Cement-Producing States
34	2.18	Factors in Marginal Plant Survival
35	2.19	Grey Portland Cement Capacity Composition by Major Cement Companies, 1971
37	2.20	Correlation of 1970 Earning Power and Average Plant Size for Multiplant Cement Companies
38	2.21	1970 Composition of Type II Plants by Company Size
40	2.22	Market Position of Selected Companies, 1950-1970
55	3.1	Bag House
56	3.2	Precipitator
60	3.3	Typical Relationship of Control Cost vs. Level of Control
64	3.4	Comparison of Federal New Source Standards with Suggested Process Weight Table
69	4.1	Portland Cement Capacity and Production, 1929-1969
71	4.2	Geographical Composition of Portland Cement Consumption (Million Barrels)
72	4.3	Geographical Composition of Annual Growth Rates of Portland Cement Consumption 1960-1969

INDEX TO EXHIBITS (Con't.)

<u>Page Number</u>	<u>Exhibit Number</u>	<u>Title of Exhibits</u>
73	4.4	1969 Market Information About 10 Largest States Ranked by Cap- acity (Million Bbl.)
75	4.5	Cement Shipment by Types of Cus- tomers
76	4.6	Composition of Cement Consumption by Customers and End Use Mar- kets, 1969
77	4.7	Portland Cement Consumption by Public and Private End Use Markets - 1969
82	4.8	Relationship Between Cement Con- sumption and New Construction Expenditures
84	4.9	Demand for Portland Cement (Mil- lion Barrels)
90	5.1	Typical Cement Manufacturing Cost
92	5.2	Realized Prices and Costs of Two Typical Cement Plants
94	5.3	Grand Average Man-Hours per 1000 Bbl. Equivalent Production
96	5.4	1971 Man-Hours/Thousand Barrels for a Major Cement Company
97	5.5	Typical Cost and Price Relation- ships in Plant Expansion Analysis
99	5.6	Historical Cement Plant Construction Costs
100	5.7	Historical Cement Plant Construction Costs

INDEX TO EXHIBITS (Con't.)

<u>Page Numbers</u>	<u>Exhibit Number</u>	<u>Title of Exhibit</u>
108	5.8	Average Kiln Size vs. Age of Kiln 17 or 20 Largest U.S. Producers
111	5.9	Fixed/Variable Costs vs. Plant Capacity
114	5.10	Selected Financial Statistics Mercury Portland Cement Company
115	5.11	Selected Financial Statistics Venus Portland Cement Company
116	5.12	Selected Financial Statistics The Good Earth Portland Cement Com- pany
118	5.13	Selected Financial Statistics Mars Portland Cement Manufacturing Company
119	5.14	Selected Financial Statistics Jupiter Fine-Ground Portland Company
120	5.15	Selected Financial Statistics Saturn Cement Company
121	5.16	Selected Financial Statistics Neptune Portland Cement Company
123	5.17	Selected Financial Statistics Uranus Cement Company
130	5.18	Cement Industry Cash Needs
136	6.1	Cement Average Realized Mill Price per Barrel
144	6.2	Trends in Labor Requirements, 1939- 1969
145	6.3	Manhours/Bbl. of Cement Produced
146	6.4	Number of Workers per Cement Plant

Section 1

SUMMARY AND ISSUES

POLLUTION CONTROL

Public awareness and concern over industrial pollution have increased sharply in the past several years. This was once the province of a small number of engineers, concerned citizens, and administrators. Now broad segments of the public, the legislatures and the executive branches of government evidence an active concern for environmental issues in general, and pollution in particular.

The cement industry is faced with the need to prevent effluent from its manufacturing process from entering the surrounding environment. These by-products include the dust and gases generated in the kilns and other plant areas as well as mineral-containing waste water.

Pollution control is a vital issue to the cement industry. The cost of eliminating stack emissions and of preventing water pollution is high. It is to a large extent a nonproductive expenditure, although some of the costs can be recovered by more complete utilization of raw material or sale of by-products.

The most significant aspect of pollution control cost seems to be the initial capital outlay, rather than the operating costs and amortization of capital. On a per barrel basis, pollution control appears to increase the total manufacturing cost of cement by about 3.7 to 6.1 percent depending on the age and condition of the plant involved. For a new plant, where adequate pollution controls are incorporated in the planning and design, capital costs will be increased by 5 to 10 percent to meet federal new plant standards.

If the value of the by-product recovered by the emission control device exceeds the cost of the device, no incentive other than the profit motive is required to have the collection device installed. Such is the case of dust control equipment in cement clinker grinding mills. Here the recovered

effluent is finished cement with a relatively high value. There is considerable economic advantage in recovery and recycling of this dust.

In most areas of cement manufacture, however, the cost of recovery exceeds the potential value of the waste material recovered. Without legislation that requires the effluent to be collected and appropriately disposed of, the only motivations for pollution control are public service, employee health and comfort, and environmental concern. Any producer who voluntarily makes such investments incurs a cost disadvantage relative to his competitors, and to that extent reduces his ability to fund continued growth, raise further capital, or pay dividends to shareholders.

Nevertheless, considerable further expenditure is required. Legislation specifying tolerable emission levels is being passed by the states and the federal government, and large expenditures will be required of the industry to meet those standards. It is the purpose of this report to determine the economic impact of pollution control expenditures on this industry, and its effect on costs, prices, capital requirements, and other effects.

There is considerable variation between the industry and the E.P.A. as to the required level of pollution control expenditures. The industry expresses a major concern about the total level of expenditures to meet current and anticipated standards. The E.P.A. recognizes that current legislation will impose increased costs on the industry, but notes that the industry already faces a cleanup cost under previous codes. It has separated these costs into those which would have been committed and those which are specifically traceable to the Clean Air Act as amended December, 1970. The industry finds these costs difficult to isolate, and has responded with some concern about the total financial burden which it anticipates.

Probably the major concern of the industry is not the total costs, but its uncertainty about how to estimate costs and how to plan for them. Under the law, the federal government has set emission standards for new cement plants. Those costs can be estimated with some confidence, though it seems a bit difficult to say how much of those costs are specifically due to the recent legislation. The federal government has also established ambient air quality standards. It is up to the states to see that those standards are met. The states must submit to the E.P.A. by early 1972 their proposed emission standards for existing plants. In short, the

federal government has specified by law the necessary quality of air throughout the nation. It has set emission standards which will apply to all new or expanded plants. The states must determine what emission standards should be applied to existing plants to meet the federal ambient air quality standards.

The cement industry expresses considerable apprehension that the emission standards applied to existing plants will be made the same as federal standards for new plants, or even that the states will make existing plant standards more strict than new plant standards. That would be very costly. It is more expensive to depollute an existing plant than a new plant of comparable size. Engineering and design costs are higher, erection costs increase substantially, and often part of the old plant must be reconstructed to accommodate the control equipment.

The economic impact of pollution control legislation can only be described as varied. The effect will be felt to much different degrees by the 50-odd U.S. producers. The basic reasons for this are the operating economics of the cement business and the financial and competitive policies pursued by the participants. There are several economic issues involved, outlined briefly below and discussed in detail later in this report.

Yet from the industry's point of view, the economic impact of pollution control depends less on issues of operating economics and competitive dynamics than on the issues of public policy and legislative action. With appropriate action on these issues, it appears that the industry is capable of absorbing the foreseeable economic impacts.

The industry overall can evidently provide the funds needed to depollute or replace its plants. In addition, the industry will be able to provide the funds required for growth in capacity at a somewhat faster rate than in the past decade. Modest changes will be required in debt policy and dividend payout over the decade, but the existing levels can be restored by 1980 or earlier. Some increase in price levels can be anticipated, but that directly traceable to pollution controls should not exceed two percent or a bit more. Yet while the industry overall can meet the financial requirements of clean air legislation, that is not true for all companies. Some plants will be shut down because there is no economic way to keep them operating with the added capital burden of pollution control equipment. In some cases, the owners of these plants will not have the financial muscle to rebuild and expand the facilities. They will become

targets for acquisition, or may simply be forced to contract or even withdraw from the cement business.

In brief, the overall impact of pollution controls on the cement industry appears tolerable, regardless of whether we consider the total cost including that already expended, or the incremental cost of current legislation only. But this impact will not be uniform throughout the industry, and will work a hardship on specific companies.

PUBLIC POLICY AND LEGISLATIVE ISSUES

One of the most serious obstacles in the path of industry compliance is uncertainty about pollution control standards. Both federal and state agencies are involved in setting standards, and requirements have not been uniform. Cost rises rapidly with small improvements in the suppression of pollutants, so cement companies normally install adequate but not excessive controls as they upgrade a plant. If standards are raised thereafter (or if enforcement becomes more stringent), the previous investment must be substantially increased. Sometimes the previous equipment is not expandable and must be scrapped. Even if expandable, the cost of successive improvements exceeds the cost of a one-time full installation. Thus, some companies have elected not to depollute cement plants until firm standards have been established. Others have complied with then existing (or even anticipated) standards, but face considerable expense as stricter laws are passed. It is probable that industry compliance will be reluctant until federal and state standards are specified as firm and applicable for, say, a five to ten year period.

Related to this is the issue of realistic emission standards. It is in principle possible to eliminate all emissions from a cement plant except hot carbon dioxide. However, the cost would be unbearably high, and would virtually shut down the industry. Well over 99 percent of particulate emissions can be eliminated, at tolerable cost in most plants, but each additional 0.1 percent of emissions eliminated adds a large and increasing fraction to costs.

A difficult issue is that of plant start-up. Particularly for wet-process cement plants (described in section 3), high levels of dust may be emitted from an otherwise well controlled plant during the start-up phase. This is to some extent an operating procedures problem, but there seems to be some doubt that it can be eliminated totally. Industry

compliance may be facilitated if some emissions are permitted during start-up activities.

One final issue of concern to the cement industry is that of consistent standards among industries. The cost of pollution control increases, as we have said, with increased levels of air quality. If the cement industry is required to meet emission and ambient air standards in excess of those for other industries, then the economic impact of pollution control will be felt more severely by cement producers than by other industries. This has been voiced by some industry spokesmen as a rather rankling point.

ISSUES OF OPERATING ECONOMICS

The cement industry is a highly fragmented, regional business. The principal product is a low value, largely undifferentiated commodity, which is uneconomic to ship over long distances. Knowledge of the technology is widespread, and there has been but little technological development in over 50 years. Thus ease of entry is high, depending primarily on access to capital and to a satisfactory limestone quarry. For these reasons, geographically separate markets have historically been served by opening small local plants rather than expanding centrally located facilities.

While that has historically been the pattern of the cement industry, the last decade has seen a steady shift. Cement plants have high fixed costs; typically 70 to 75 percent of total cost at full capacity is fixed. This creates high operating leverage. But the fixed costs for a large plant are substantially less than the total for two small plants of equivalent total capacity (largely because twice the capacity does not demand twice the labor). Fuel and power economy are improved in large plants as well, giving large plants a considerable cost edge if they operate near full rated output. For this reason, there is a steadily rising trend in the construction of large cement plants.

Larger plants of course must serve larger markets. Since the distribution cost of cement is high (typically one-third to one-half of production cost), some of the advantages of scale are offset by costs of distribution. Nevertheless, the trend is unmistakably in favor of larger plants serving larger areas, with the ability to deliver cement at prices below those of smaller, nearer plants. This means that smaller, usually older, plants are irresistibly being

forced out of business. Many have already been shut down.

Pollution control legislation has the apparent effect of hastening this process. Because a large portion of cost is depreciation, even a high cost, inefficient small plant can generate a cash contribution when prices are below full accounting costs. For this reason, smaller plants can withstand the pressures of competition from large, modern plants for a considerable time. With the slow growth in cement demand, and the ability of small plants to operate at reported losses for many years, the potential operating economies of large new plants have not taken over in the industry as rapidly as they otherwise might. Yet the small cash flow from a small, old plant is insufficient to justify the capital required for installing a modern pollution control system. The advent of strict environmental controls therefore forces closing of plants several years before economic pressures would normally take their toll. Section 5 of this report shows the economics of small and large plants.

The cost of pollution controls is normally higher for old plants as well. System costs vary only modestly with plant scale, so the per barrel cost of controls on older, typically smaller, plants is higher than for new, typically larger, plants. Also, old plants characteristically lack the space, power supplies, and other physical capacity for easy installation of these devices. Therefore the engineering and construction costs are often higher when depolluting an old plant than a new one.

Typical costs for meeting current and anticipated standards in existing plants are, approximately, \$1.00 per barrel of capacity. That figure is an average of estimates provided by industry leaders, based on actual expenditures, engineering studies, and supplier estimates. It includes costs already incurred, and projected future expenditures. More detail on these costs is given in an appendix. The E.P.A. reports that typical costs for bringing existing plants up to the proposed new standards will be about \$0.20 per barrel. The difference arises because the E.P.A. has included only incremental costs of new standards, over and above amounts already spent and estimated expenditures previously required.

Although operating and amortization costs are not severe, the initial capital outlay for a large plant can be several million dollars. These costs must be met, sooner or later, by profits. The cement industry has for some years suffered low and declining profits, which has restricted both

internal cash generation and ability to raise new capital for many firms. Doubtless this has had some impact on investments in pollution control.

The decline in cement industry profitability can be traced again to the economics of competition. During the late 1950's and early 1960's, demand was forecast to grow at four percent or better. Numerous new plants were built, often with large capacities, to meet this expectation. Demand actually grew more slowly, and the industry suffered continued overcapacity throughout the 1960's. Prices suffered, costs of fuel and labor rose, and profits generally deteriorated. Currently, however, capacity and demand have arrived at a closer balance, with the general expectation of overall improved profitability.

The real issue of profitability improvement is who will benefit from the current conditions. It is clear that those firms with the most leveraged operating (and financial) structures stand to gain the most; in other words, companies with large and modern plants. If they deploy their improved profits toward gaining market share, as they should, then again the pressure on older, smaller plants will be increased. They may be forced to shut down, in the face of improved markets, as market share shifts to firms with large plants having unused productive capacity.

Some smaller plants will be protected from this overall trend due to their geographical isolation. For these plants, the economic impact of pollution abatement can be severe. Initial capital costs can be high. They will be able to raise prices to recover those costs over time, as their markets may be substantially unaffected by lower cost plants due to the distances involved. Yet it is possible that raising the necessary capital could work a hardship on them at least temporarily, and conceivably lead to plant closings which would not otherwise occur through competition.

The cement industry is clearly in a state of transition. Some producers are aggressively using financial weapons and large capacity expansions to cause shifts in market share. Other companies are quietly (and perhaps unwittingly) withdrawing from the business. Several large, well-funded conglomerates have entered the industry, and show every evidence of their intention to compete vigorously. This transition is protracted over a long period, but it is proceeding steadily. In the face of this change, pollution control requirements cause an extraordinary need for capital, and create a cost impact which differs among competitors. The effect is to exacerbate the existing insta-

bility. While some firms will be undoubtedly hurt by pollution control demands, it becomes difficult and perhaps impossible to isolate those impacts from the inexorable effects of competitive strategies being employed by others.

It is especially difficult to isolate these effects because the regional distribution pattern of the industry operates within a largely national price structure. When a producer in one region lowers his prices, for example to fill a new plant, other producers in that region may find it more advantageous to pay the extra freight cost to ship to an adjoining region. This excess of supply then depresses prices there, and the process continues nation wide. Thus although prices differ throughout the country, reflecting supply-demand balance and local costs, changes in price level in any area tend to be duplicated elsewhere (at least directionally) within a short time. Consequently, severe competition in, say, the Chicago area may hasten the demise of a plant in Atlanta faced with a large depollution expenditure, even though these plants otherwise operate quite independently.

Section 2

INDUSTRY DESCRIPTION

PRODUCTS, MARKETS AND PRODUCERS

The cement industry basically manufactures one product, portland cement. Cement is a powder which, when mixed with water, will solidify into a hardened mass which is strong and durable. Portland cement is a hydraulic cement, which means it will harden under water. Normally, cement is mixed with sand and either gravel or crushed rock in such proportions as 1:2:3 before adding water. The resulting product is concrete. The sand and aggregate do not appreciably affect strength or durability, but lower the cost per cubic yard substantially.

Fifty-three companies engaged in the manufacture of cement in the U.S. operate about 180 plants. Industry sales in 1970 (mill net) were about \$1.3 billion. These firms range in size from Ideal Cement (division of Ideal Basic Industries), the largest, which has 17 plants with 40 million barrels of cement capacity and consolidated sales of \$130 million, to Utah Portland Cement with one plant, 900,000 barrels of capacity, and sales of \$3.2 million. Half the companies in the industry operate more than one plant. The ten largest firms have about 40 percent of the total industry capacity.

Destinations of cement shipments in the U.S. are listed in the table below.

CEMENT SHIPMENT DESTINATIONS

<u>Destination</u>	<u>Percent of Shipments</u>
Ready-mix concrete firms	60
Block and pipe manufacture	13.5
Highway contractors	10
Building material dealers	8
Contractors	4
Others	4.5
	<u>100.0%</u>

Ready-mix firms purchase cement and aggregate, mix these materials with water at a blending plant and deliver the unset concrete to a job site ready to be poured. Concrete products manufacturers purchase raw cement and produce cast products of concrete such as pipes, blocks, or prestressed beams. These products are then sold to the construction industry. Contractors often do their own mixing of the cement, water and aggregate, either at the job site or at a mixing plant. Building materials dealers purchase the cement, usually in sacks, for resale to small contractors, tradesmen, and individual users.

Poured concrete and concrete products are employed in applications requiring a high degree of compressive strength, a durable, low-maintenance surface, and long life. A recent analysis (1969) of the uses of concrete in the U.S. is shown in Exhibit 2.1.

TYPES OF CEMENT COMPANIES

Of the 53 firms in the U.S. cement industry, 26 companies have single plant operations and 27 are multiplant companies. Exhibit 2.2 lists the companies and their operating capacities as of 1969. Because there have been very few plant closings or openings, this list is substantially unchanged for 1971. Exhibit 2.3 shows the industry composition according to number of plants.

CONCENTRATION OF CEMENT PRODUCERS

Cement is a very heavy product, with quite a low value-to-weight ratio. Typical delivered price is about one cent per pound, one of the lowest prices of any manufactured product. Supplies of limestone and other raw materials are abundant, so cement is normally manufactured close to the point of use, rather than being shipped long distances. The cement industry in the U.S. has evolved as a rather fragmented, regional business for that reason.

Because it is a regional business, the cement industry is not highly concentrated. Rather than a few producers having plants nation wide, the tendency has been for each cement company to own only a few plants (generally in a single region), or even a single plant. Possibly this is because interplant economies are low, being limited primarily to administrative cost reductions. There has been some concentration of the industry through acquisition and merger, though the impact is low. Exhibit 2.4 shows capacity concentration ratios for three selected years.

EXHIBIT 2.1

USES OF CONCRETE IN THE U.S.

	<u>Million Barrels</u>	<u>Percent</u>
Residential Construction		
Multifamily	46	11
Single	33	8
Maintenance, hotel, motel	<u>17</u>	<u>4</u>
Total	96	23
Public Works		
Streets and highway	79	19
Bridges, airports	<u>59</u>	<u>14</u>
Total	138	33
Public Buildings		
Schools	20	5
Administration, recreation	<u>38</u>	<u>9</u>
Total	58	14
Industrial and Commercial	87	21
Farm and Miscellaneous	<u>38</u>	<u>9</u>
TOTAL	417 bbl.	100%
Net Imports	<u>8</u>	
U.S. Production	409	

One barrel = 376 pounds of cement. One cubic yard of concrete requires 1.375 barrels. On January 1, 1972 the U.S. cement industry will switch to tons as a standard unit of measurement in conformance with world practice.

EXHIBIT 2.2

U.S. CEMENT COMPANIES IN ORDER OF SIZE - 1969

<u>Company Rank</u>	<u>Capacity) (Millions of bbl)</u>	<u>No. of Plants</u>
1 Ideal Cement Div. Ideal Basic Industries	39.9	17 ¹
2 Lone Star Cement Corp.	32.7	12
3 Universal Atlas Cement Co.	31.5	12 ¹
4 General Portland Cement Co.	27.3	10 ²
5 Martin Marietta Corp.	25.9	9 ³
6 American Cement Corp.	25.2	9 ¹
7 Marquette Cement Co.	24.3	12
8 Lehigh Portland Cement Co.	23.4	11
9 National Gypsum Co.	21.0	2
10 Kaiser Cement and Gypsum Co.	19.7	5
11 Penn Dixie Cement Corp.	17.1	8
12 Alpha Portland Cement Co.	15.5	8
13 Southwestern Portland Cement Co.	15.1	5
14 Medusa Portland Cement Co.	15.0	5 ²
15 The Flinkote Co.	14.0	5
16 California Portland Cement Co.	13.1	3
17 Dundee Cement Co.	13.0	2
18 Puerto Rican Cement Co.	11.5	3 ¹
19 Louisville Cement Co.	11.15	3
20 Missouri Portland Cement Co.	11.0	3
21 Atlantic Cement Co.	8.5	1
22 Columbia Cement Co.	6.9	3
23 Ash Grove Cement Co.	6.3	2
24 River Cement Co.	6.0	1
25 Giant Portland Cement Co.	5.3	2
26 Oregon Portland Cement Co.	5.2	2
27 Monolith Portland Cement Co.	5.1	2
28 Arkansas Cement Corp.	5.0	1
29 Texas Industries	5.0	1
30 Coplay Cement Co. (incl. Nazareth subsidiary)	4.4	2
31 Northwestern States Portland Cement Co.	4.25	1
32 Hudson Cement Co., Div. Colonial Sand & Stone	4.0	1
33 OKC Corp.	3.7	2

EXHIBIT 2.2 (Cont.'d)

U.S. CEMENT COMPANIES IN ORDER OF SIZE - 1969

<u>Company Rank</u>	<u>Capacity</u> (Millions of bbl)	<u>No. of Plants</u>
34 Keystone Portland Cement Co.	3.3	1
35 Pacific Western Industries	3.3	1
36 Whitehall Cement Co.	2.9	1
37 San Antonio Portland Cement Co.	2.5	1
38 Monarch Cement Co.	2.4	1
39 South Dakota Cement Plant	2.4	1
40 Maule Industries	2.0	1
41 National Cement Co.	2.0	1
42 National Portland Cement Co.	2.0	1
43 San Juan Cement Co.	2.0	1
44 Santee Portland Cement Corp.	2.0	1
45 Wyandotte Chemicals Corp.	2.0	1
46 Capitol Aggregates, Inc.	1.7	1
47 Gifford-Hill Portland Cement Co.	1.5	1
48 Gulf Coast Portland Cement Co.	1.5	1
49 Centex Cement Corp.	1.4	1
50 Mississippi Valley Portland Cement Co.	1.2	1
51 Century Cement Co.	1.0	1
52 Nevada Cement Co.	1.0	1
53 Portland Cement Co. of Utah	.9	1
54 Riverton Lime & Stone Co. - Grinding plant only	--	1
55 G.&W.H. Corson - Grinding plant only	--	1
TOTAL	511.6	184

Notes: 184 minus 3 grinding plants = 181 active portland cement plants

¹One white cement plant included in total

²Two white cement plants included

³Includes one grinding plant

Source: Rock Products, May 1969

EXHIBIT 2.3

COMPOSITION OF COMPANIES BY NUMBER OF PLANTS

	<u>No. of Companies</u>	<u>Percent</u>
Single plant operations	26	50
Multiplant operations	27	50
with three or fewer plants	13	25
with more than three plants	14	25
Total companies	53	100%

EXHIBIT 2.4
CAPACITY CONCENTRATION RATIOS
CONTINENTAL U.S. PORTLAND CEMENT*

	1950		1964		1969	
	(mm bbl)	%	(mm bbl)	%	(mm bbl)	%
A: 4 largest companies	91	33%	137	29%	130	26%
B: 5-8 largest companies	40	15%	99	21%	99	20%
C: 9-20 largest companies	67	25%	155	33%	166	33%
D: all other companies	73	27%	79	17%	105	21%
TOTAL	271	100%	470	100%	500	100%

Note: *excluding Puerto Rico

Source: Pit & Quarry Handbook, 1951 and 1964
Rock Products, May 1969

Exhibit 2.4 indicates that the four largest companies, which have differed during this period, have on average been losing market position. Their share has been consistently declining over the past two decades, reflecting an apparent trend towards less concentration. But this is misleading. Overall, concentration is increasing in the cement industry. New entries by noncement companies accelerated the growth in capacity in group C. Members of group D hardly expanded their capacity in the mid 50's when most other companies did, but began to improve their position in the past five years by modernization and addition of new capacity. These programs must have been very intensive since the total number of companies in category D declined from 44 in 1950 to 32 in 1969.

This exhibit gives the first indication of a pattern of change which we shall see recurring throughout this report. Most of the traditional cement companies seem to be sacrificing market position, by investing in new capacity (or expansions) less rapidly than a group of new entrants in the business. Only a few companies with long histories in cement, such as Ideal, Lone Star, and Medusa have invested heavily. Up to now, this trend shows up as increasing concentration among smaller companies, and dislocation of former industry leaders by faster growing competitors. For numerous economic reasons cited later, we expect this concentration to continue, leading to an industry with fewer competitors, fewer plants, larger plants, and more plants per company. In ten years, the four largest companies (possibly not today's leading four) will probably again have at least one-third of the industry's total capacity.

PLANT SIZE DISTRIBUTION

An analysis of trends in the size distribution of plants reveals some very interesting and conclusive patterns.

Plants are classified by size into the following types:

<u>Type</u>	<u>Capacity (mmbbbls/year)</u>
I	less than 1
II	1 to 2
III	2 to 3
IV	3 to 4
V	4 to 5
VI	5 and over

Exhibit 2.5 shows the trend in distribution among these types during the past twenty years.

During the period of 1950 to 1967 the number of plants increased steadily. Most recently this trend reversed even though capacity increased, indicating a continued structural change in the cement industry. Large plants replaced small plants.

Prior to 1956 small plants went through a serious shake-out phase. As shown in Exhibit 2.6, within only six years (1950-1956) the total number of these small plants declined by more than 50 percent, from 25 to 11, a net change of 14 plant shutdowns. Thereafter, the situation stabilized and the number of plants in this group oscillated around nine. Seven of the eleven small plants in 1970 are white cement installations which are adjacent to large gray portland cement plants. In the long run, we do not expect any significant changes in this group except that the four remaining portland cement plants are likely to be closed or else substantially expanded in the near future. All four of these small plants are located in highly competitive areas which are characterized by extremely low mill prices.

Exhibit 2.7 shows a similar decline in one to two million barrel plants. After a peak in 1953, shutdown of 31 installations occurred within six years. Overall the number of plants in this group has been decreasing, and we anticipate a continuation in the decline at about nine plants for every five years in line with a trend extrapolation. Two-thirds we expect to be shutdowns, and one-third of the plants will be upgraded through capacity additions and modernization programs to larger plants.

The graph of Type III plants, Exhibit 2.8, shows the number of these plants rose rapidly initially and then slowly increased, reaching a plateau in 1962 and 1963. Since then, the number has consistently declined. Approximately 50 percent of those plants leaving this group will be modernized and upgraded to larger plants.

The graph of Type IV plants, Exhibit 2.9, clearly shows a constant increase of about seven to eight plants for every five year period during the past two decades. This trend we expect to continue in the future. Our views here are different from several respected industry spokesmen. They feel that the optimum size of kiln is 2-2.5 million barrels, so that optimum plant size is Type III (with one kiln) or type

EXHIBIT 2.5

TRENDS IN SIZE DISTRIBUTION OF PLANTS, 1950-1970
(Number of Plants)

TYPE OF PLANT YEAR	I	II	III	IV	V	VI	TOTAL
1950	25	85	29	13	-	-	152
1951	23	86	34	13	-	-	156
1952	21	88	33	15*	-	-	157
1953	20	85	39	12	-	-	156
1954	17	85	44	11	-	-	157
1955	13	79	49	16	-	-	157
1956	11	67	57	18	6	-	159
1957	11	62	56	20	7	7	163
1958	10	59	58	24	9	7	167
1959	10	57	58	28	10	8	171
1960	10	57	62	28	10	9	176
1961	8	58	61	28	12	9	176
1962	7	58	64	28	11	11	179
1963	8	55	64	31	12	11	181
1964	9	53	62	34	11	12	181
1965	8	57	56	36	13	11	181
1966	11	60	53	33	13	14	184
1967	11	59	52	40	12	14	188
1968	7	58	53	36	13	16	183
1969	8	55	53	36	12	17	181
1970	11	48	47	42	14	18	180

Note: *In the period 1952-1956 all plants with capacity of 3 million barrels and over were classified into Type IV.

Source: U.S. Department of Interior
Bureau of Mines Yearbook, 1950 through 1969
1970 - The Boston Consulting Group estimates

EXHIBIT 2.6

TYPE I
(Plants With Less Than 1 Million Bbl. Capacity)

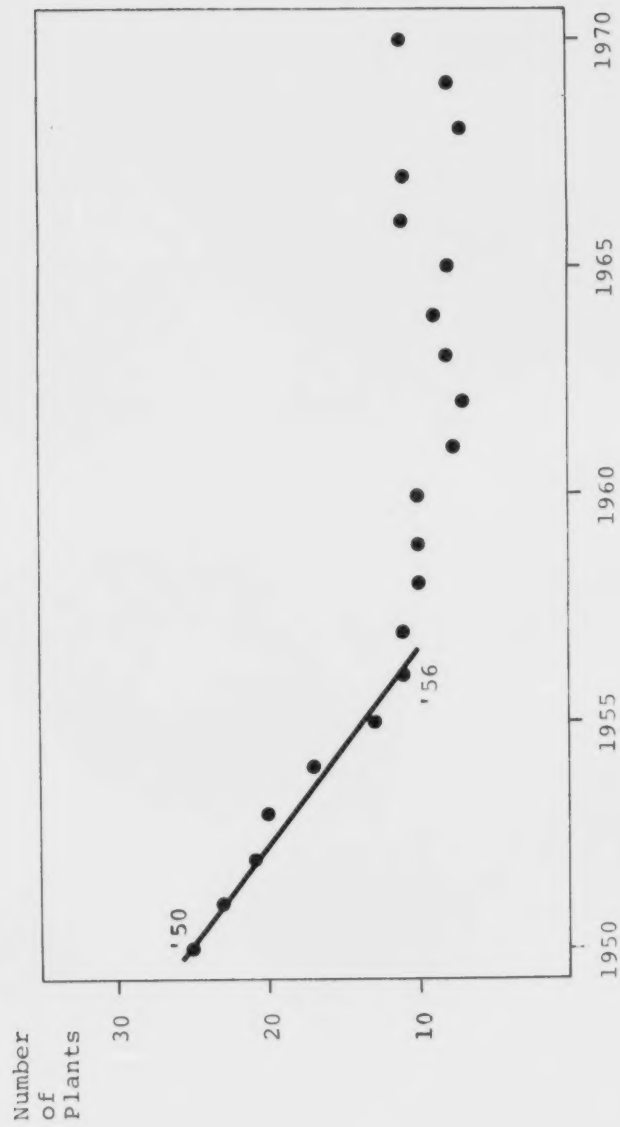


EXHIBIT 2.7
TYPE II
(Plants With 1-2 Million Bbl. Capacity)

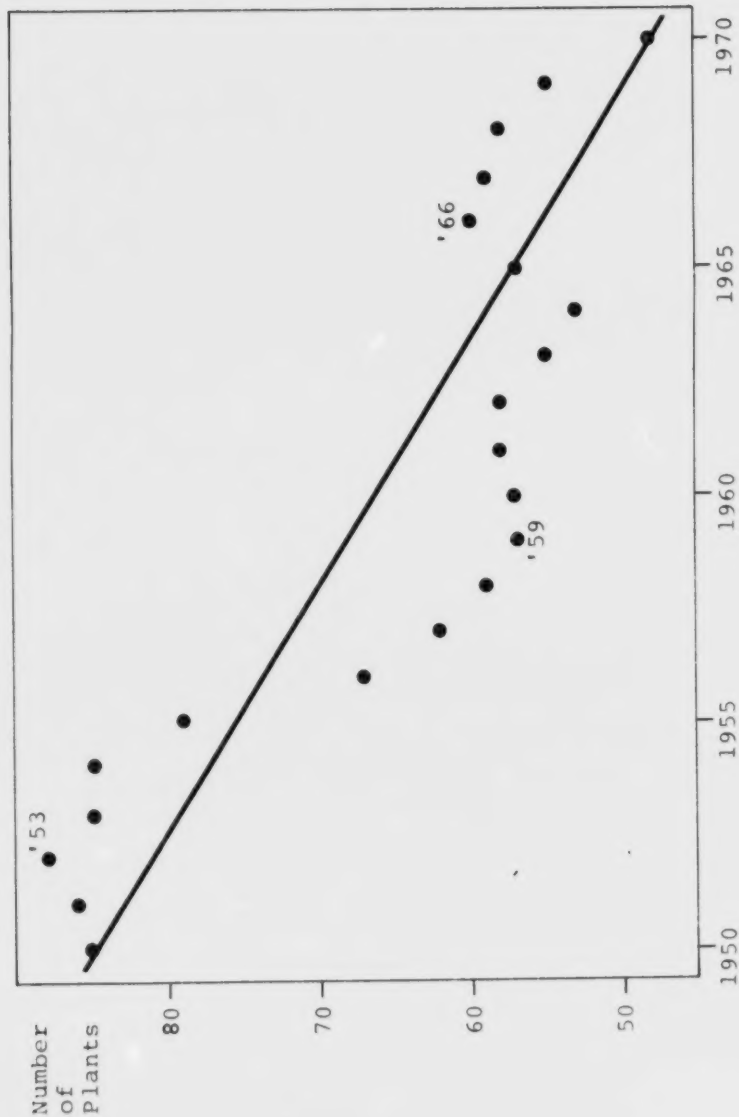


EXHIBIT 2.8
TYPE III
(Plants With 2-3 Million Bbl. Capacity)

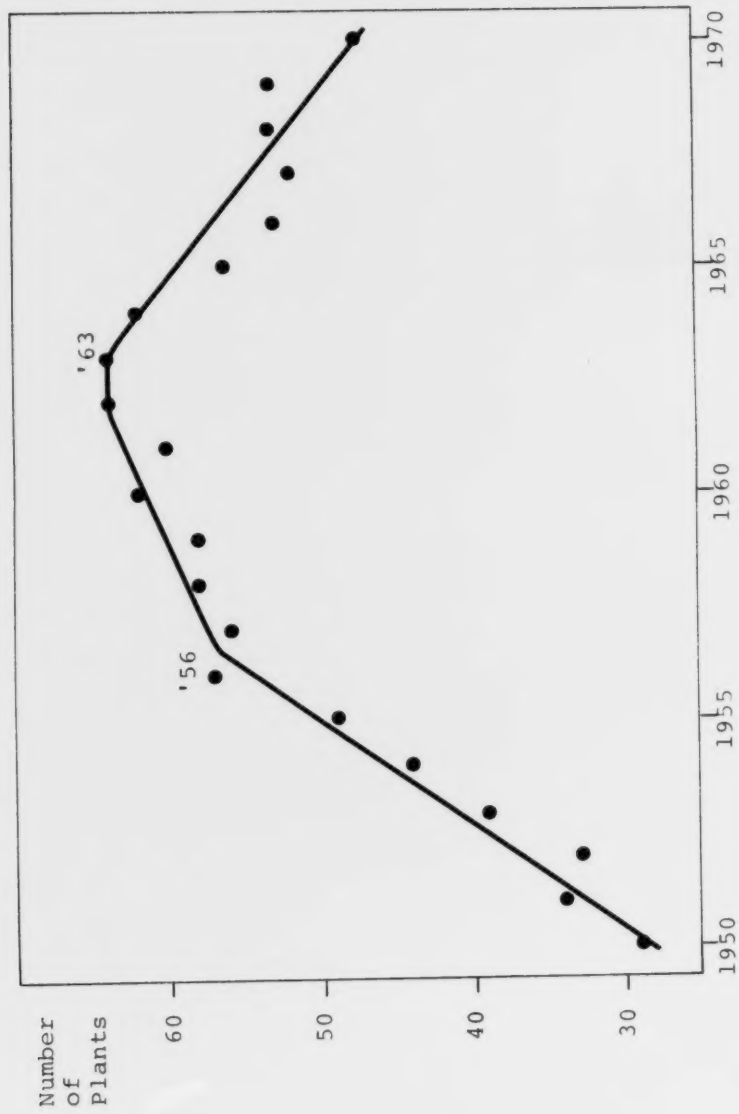
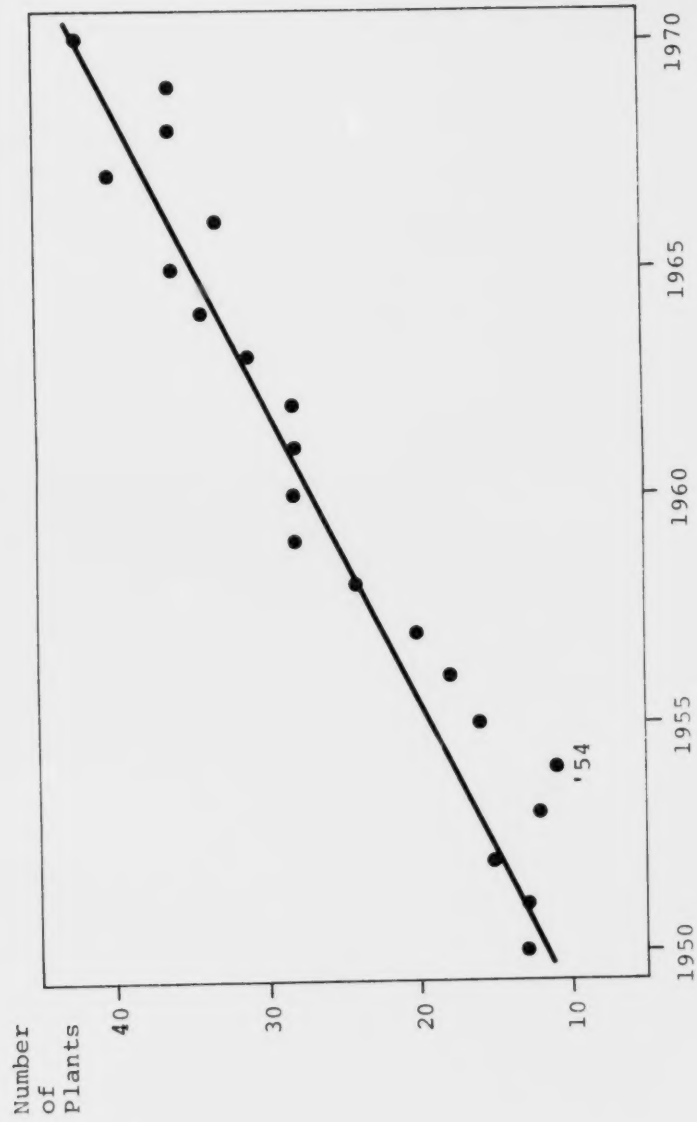


EXHIBIT 2.9
TYPE IV
(Plants With 3-4 Million Bbl. Capacity)



V (with two kilns). Statistically, however, kiln size is trending upward and average kiln size built during the 1970's is likely to be 3-3.5 million barrels. Plant sizes will then be Type IV or Type VI, which is where we expect the most growth. If this were to happen, it would change profoundly the pricing and distribution patterns of the industry, which is just what we expect to see.

In the period of 1956-1961 the number of Type V plants increased steadily as illustrated in Exhibit 2.10. But growth slowed considerably in the 1960's. About three to four new plants can be expected to be built within the next ten years.

We would argue that almost any Type V plant is liable to be an uneconomic decision, unless it is a one kiln plant operated almost continuously. Kilns above four million barrels are difficult to design and run efficiently. U.S. producers have not had good results with such kilns, although European and Japanese companies have done very well with giant kilns. But if not a giant single kiln, then a Type V plant must have two 2-2.5 million barrel kilns, which appear to be uneconomically small today for a new plant in a major market area. In most cases, it appears that a producer contemplating a Type V plant would do well either to widen or to narrow his market definition or intensify his penetration plans.

The number of Type VI plants, Exhibit 2.11, has been increasing very consistently over the years. During the period of 1965-1970 six plants were added to this group. We estimate the construction of about 12 such plants over the next ten years.

Our estimates of new plant construction are not simple trend extensions. The trend to larger plants is based on sound economics. The rate at which the industry can shift to larger plants is controlled strongly by market growth. We expect demand growth will increase during this decade, accelerating the shift to larger plants and increasing the pressure to close older, smaller plants. Most of these new plants will be built at existing quarry locations, so the net employment impact of plant closings will be low.

The summary graph, Exhibit 2.12, clearly shows that the number of plants with less than three million barrels annual capacity is declining and those with greater than three million barrels capacity is increasing. Exhibit 2.13 summarizes plant size distribution in 1956 and 1969.

EXHIBIT 2.10

TYPE V
(Plants With 4-5 Million Bbl. Capacity)

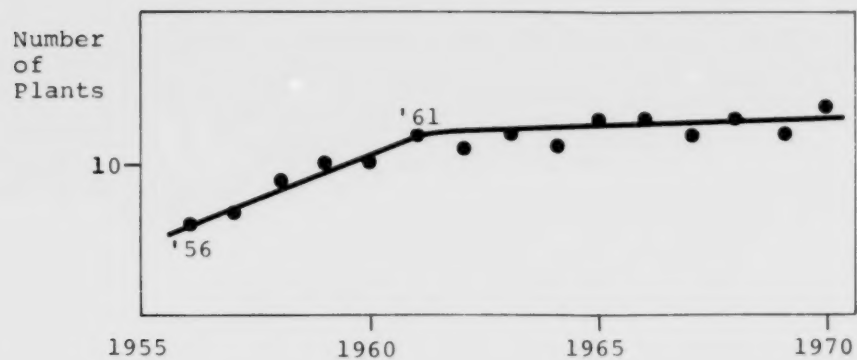


EXHIBIT 2.11

TYPE VI
(Plants With 5 Million Bbl. Capacity and Over)

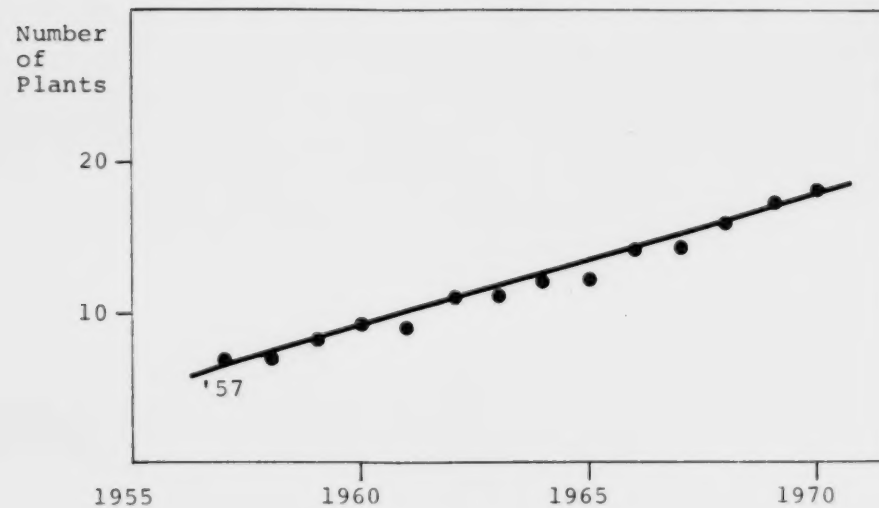


EXHIBIT 2.12
SUMMARY GRAPH FOR ALL SIX PLANT TYPES

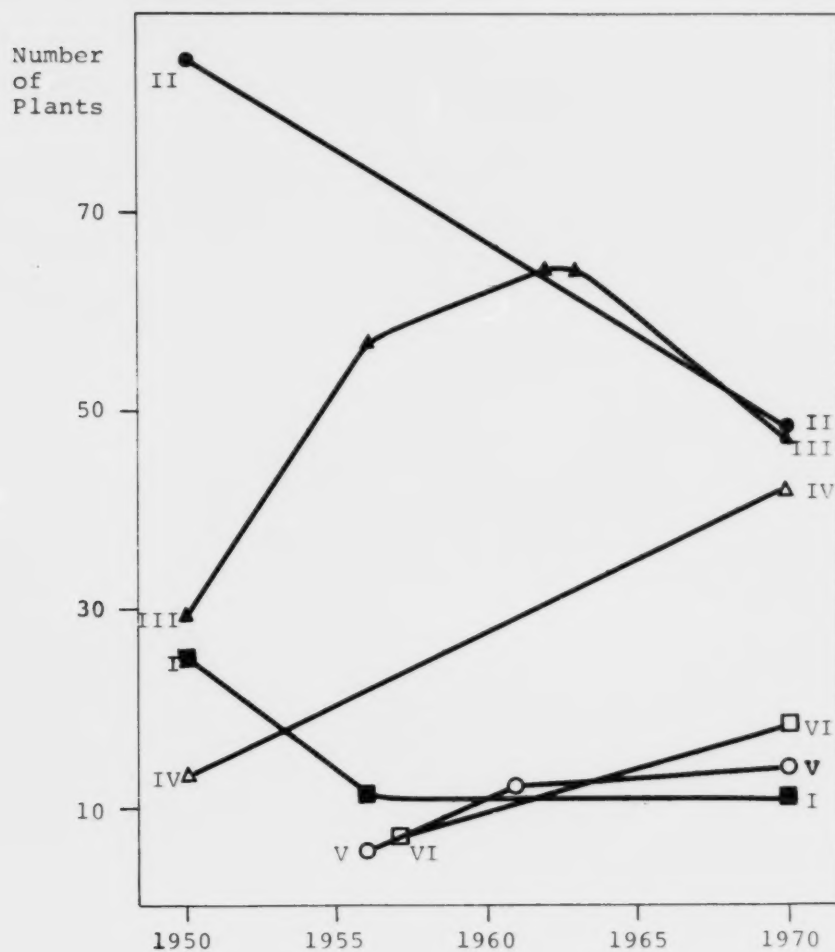


EXHIBIT 2.13

TRENDS IN SIZE DISTRIBUTION OF PLANTS

Year	Plant Type	I	II	III	IV	V	VI	Total
1956	% of Industry	2.4	28.4	38.5	18.2	12.5	--	100%
1969	Capacity	1.0	16.4	25.3	24.1	10.0	23.2	100%

Source: Bureau of Mines Minerals Yearbook, 1956 and 1969

A dramatic change has taken place in the cement industry. In general, plants of Type II and III are being replaced by those of Type IV and VI. Type V plants (capacity of four to five million barrels) appear to be of an odd size. The trend towards large plants indicates that further increases in the production economies of scale are profitable.

Extending these well established trends, in conjunction with demand estimates developed in section 4 of this report, permits a glimpse into the probable future structure of the cement industry (Exhibit 2.14). These estimates of capacity are based on no increase in cement usage per dollar of construction, and no increase in growth rate of new construction.

The capacity requirements may be much higher, however. We expect increases in both construction growth rate and cement usage in construction. Our estimates of the potential effect of such growth on total capacity requirements may be high, since future operating rates, imports of cement, and the like can have a profound impact. Exhibit 2.15 summarizes our estimates of total capacity needs in 1975 and 1980, assuming domestic shipments approximate U.S. production and the industry has an 80 percent operating rate. The estimates in Exhibit 2.15 bracket our range of demand forecasts. The total construction of new plants will be higher than net additions, as some plants will be replaced for reasons of pollution control or size economics.

The implications in any case are clear. The cement industry will add capacity steadily over the next ten years, almost exclusively in large plants of over three million barrels. Growth in cement use per dollar of construction will demand even more large plants, increasing the competitive pressure on uneconomic smaller plants.

PLANT LOCATION DISTRIBUTION

The distribution of small and large plants varies considerably throughout the nation. In general, small plants are clustered in the Middle Atlantic, Mountain, and West South Central regions. Larger plants are found in the Pacific region, especially California, and in the East North Central area such as Michigan, Ohio, and Indiana. Exhibit 2.16 summarizes the distribution throughout the United States.

Those areas with a relatively large number of small plant operations are likely to be the most competitive territories for the marginal cement producers. The sparsely

EXHIBIT 2.14
FUTURE ESTIMATES OF PLANT SIZE DISTRIBUTION
(Number of Plants)

Plant Type	I	II	III	IV	VI	Total No. of Plants	Rated Capacity (Million Bbl.)
1970	11	48	47	42	14	180	516
1975	10	39	41	50	16	180	584
1980	8	30	35	58	18	179	633

129

Annual compound growth rate of capacity (1970-1980)=2.0 percent
With higher demand growth, Type IV and Type VI plants will increase more rapidly.

Source: Boston Consulting Group estimates

EXHIBIT 2.15
POTENTIAL CAPACITY REQUIREMENTS
(Million Barrels)

	<u>1975</u>		<u>1980</u>	
	<u>Low</u>	<u>High</u>	<u>Low</u>	<u>High</u>
Domestic Shipments	482	503	561	608
Capacity	603	629	701	760

Source: Boston Consulting Group estimates

EXHIBIT 2.16
1970 GEOGRAPHICAL PLANT SIZE DISTRIBUTION

	<u>Plant Type</u>		Total
	I-III <3 mill bbl.	IV-VI >3 mill bbl.	
Northeast Region	19	13	32
New England Division	-	1	1
Middle Atlantic Division	19	12	31
North Central Region	20	27	47
East North Central Division	10	16	26
West North Central Division	10	11	21
South Region	43	21	64
South Atlantic Division	10	9	19
East South Central Division	14	2	16
West South Central Division	19	10	29
West Region	20	13	33
Mountain Division	12	1	13
Pacific Division	8	12	20
Puerto Rico	2	2	4
Total	104	76	180

Source: The Boston Consulting Group

populated Mountain Division will be less affected since high transportation costs prohibit the construction of large cement plants.

The Middle Atlantic Division and the East South Central Division appear to be two areas with many small marginal producers all fiercely competing for survival. These regions are likely to have a large number of plant closings and plant expansions, with generally more consolidation of production.

On a state by state basis the distribution of large and small plants is even more striking. This is shown in Exhibit 2.17. The two largest cement-producing states, California and Pennsylvania, have almost exactly opposite plant size structures.

Texas, Pennsylvania, New York, and Alabama are states with the largest number of small plant operations. Many of these will close or be expanded. Past and future growth in cement usage, price per barrel, percentage of production exported, the threat of foreign imports, and the number of small plants have been identified as key variables in locating the critical markets in which marginal plants are most likely to close their operations. Exhibit 2.18 summarizes these conditions for those four states. A high growth rate, well established prices, and, most important, local isolated markets seem to protect the marginal producer in Texas. The other three states are areas in which it may be significantly more difficult for a marginal producer to survive than in other states. Our estimates indicate that Type II plants are more likely to shut down than those in other categories.

PLANTS BY COMPANIES

There are pronounced differences among competitors in the cement industry in their strategies for number of plants, plant size, and total scale of operations. As illustrated in Exhibit 2.19, the twenty largest producers have from two to fifteen plants with an average capacity ranging from two million barrels to nine million barrels.

The six largest firms (Ideal, Lone Star, Universal Atlas, General Portland, Martin Marietta, and Marquette) seem to have a strategy of participating in a large number (9-15) of markets with plants of generally modest size. Only one of these companies (Martin Marietta) has an average plant size which substantially exceeds the industry average. Penn-Dixie and Alpha pursue this strategy on a more limited scale.

EXHIBIT 2.17
PLANT SIZE DISTRIBUTION IN TEN LARGEST CEMENT-PRODUCING STATES

	1970 Capacity (million bbl.)	Total Number of Plants	Plants below 3 mill. bbl. capacity	Plants above 3 mill. bbl. capacity
1. California	60.3	13	2	11
2. Pennsylvania	52.1	20	13	7
3. Texas	49.2	21	15	6
4. Michigan	42.5	9	3	6
5. New York	33.3	11	6	5
6. Missouri	33.0	8	1	7
7. Indiana	22.9	5	1	4
8. Ohio	18.8	7	4	3
9. Alabama	17.1	7	6	1
10. Florida	14.7	4	3	1
Ten state total	343.6	105	54	51
U.S. Total	522	180	104	76
% in ten states	67%	58%	52%	67%

Source: The Boston Consulting Group estimates

EXHIBIT 2.18

FACTORS IN MARGINAL PLANT SURVIVAL

	Growth in Cement Usage		Export* Dependence	Foreign Import Threat	Prices per bbl.	No. of Small Plants
	Past	Future				
Pennsylvania	High	Low	54%	Hi	Lo	Hi
New York	Low	Low	31	Hi	Lo	Hi
Alabama	Low	High	55	Hi	Lo	Hi
Texas	High	High	16	Lo	Hi	Hi

* Exports = Shipments to other states

Note: High-Low relative to national average

Source: The Boston Consulting Group

EXHIBIT 2.19

GREY PORTLAND CEMENT CAPACITY COMPOSITION
BY MAJOR CEMENT COMPANIES, 1971

<u>Rank</u>		<u>Capacity</u>	<u>Number of Plants*</u>	<u>Avg. Size Plant</u>
1	Ideal	38.1	15	2.6
2	Lone Star	32.7	12	2.7
3	Universal Atlas	30.3	10	3.0
4	General Portland	29.7	9	3.3
5	Martin Marietta	25.8	9	3.0
6	Marquette Cement	24.3	12	2.0
7	American Cement	24.2	7	3.5
8	Kaiser	19.7	5	4.0
9	Lehigh	18.5	6	3.1
10	National Gypsum	18.0	2	9.0
11	Penn Dixie	17.1	8	2.1
12	Southwestern	15.1	5	3.0
13	Medusa	14.9	5	3.0
14	Flintkote	14.0	5	2.8
15	California Portland	13.1	3	4.4
16	Dundee Cement	13.0	2	6.5
17	Alpha	12.8	6	2.1
18	Puerto Rican Cement	11.3	2	5.7
19	Louisville Cement	11.2	3	3.7
20	Missouri Cement	11.0	3	3.7

Note: *Excluding white cement installations

Source: The Boston Consulting Group estimates

Other firms, notably National Gypsum, Dundee, Puerto Rican Cement, and California Portland, take a quite different approach of one or a few very large plants.

Among the smaller firms, this pattern is duplicated with such firms as Columbia Cement, Coplay, and OKC Corporation having more than one small plant, versus such firms as Atlantic Cement, River Cement, and Arkansas Cement owning a single very sizeable plant.

Average plant size in a company's plant portfolio seems to be a good indicator of a firm's strength for survival. There are three companies with significantly smaller sized plants among the top 20 producers:

- Marquette Cement Company,
- Penn Dixie Cement Company, and
- Alpha Portland Cement Company

Average plant size appears to correlate well with profitability of a cement company. The 1970 return on asset figures of multiplant cement companies (Exhibit 2.20) tend to improve as the average plant size increases.

We have previously noted that most plants with less than one million barrels of capacity are likely candidates for closing, unless they are white cement plants. The next most likely candidates are plants with one to two million barrels capacity, again because of the unfavorable operating economics of small plants. It is probable that the closings of these small plants will most seriously affect the large multiplant companies, rather than single plant companies. (The exceptions would be firms such as Ideal, whose smaller plants are generally in geographically remote areas with small markets.)

As shown in Exhibit 2.21, the 20 largest producers are all multiplant companies. They own 35 of the 48 one to two million barrel plants, with the greatest concentration of small plants in the four largest companies. Of the 33 smaller producers, 26 have only a single plant--yet all but seven of these plants have more than two million barrels of capacity. Those seven plants are located in high growth or protected areas like Texas and Nevada, and are therefore reasonably secure.

There are seven multiplant companies among the 33 smaller producers. Together they operate six plants of one to two million barrels capacity. Most of those are in the

EXHIBIT 2.20

CORRELATION OF 1970 EARNING POWER AND AVERAGE
PLANT SIZE FOR MULTIPLANT CEMENT COMPANIES

	<u>Average Plant Size</u>	<u>1970 Return on Assets*</u>
Alpha	2.1 million bbl.	1.2%
Lehigh	2.6	1.5
Medusa	3.0	4.5
Ideal**	2.6	4.6
Kaiser	4.0	5.8
General Portland	3.3	8.1

Notes: *Includes the return on non-cement business

**Leading producer in many isolated but profitable areas

Source: The Boston Consulting Group

EXHIBIT 2.21

1970 COMPOSITION OF TYPE II PLANTS BY COMPANY SIZE

	<u>No. of Plants</u>		<u>No. of Companies</u>	
A: 1-4 largest companies	10		4	
B: 5-8 largest companies	9		4	
C: 9-20 largest companies	16		12	
D: Other: multi plant	6		7	
	13		33	
single plant	7	—	26	—
Totals	48		53	

Source: The Boston Consulting Group

Mountain region, which for the foreseeable future is not attractive for large plant operation. Those six plants also appear reasonably secure.

The remaining one to two million barrel plants, those operated by the top 20 companies, are primarily in highly competitive regions such as the Middle Atlantic and East South Central. Their demise may be hastened by pollution control regulations, but they appear vulnerable to competitive economics in any event.

COMPETITION AND GROWTH

Although overall concentration ratios in the cement industry have changed only modestly, those statistics mask a rather dramatic shift in competitive positions. This in turn seems to show a distinct difference in investment philosophy by the major competitors. During the past twenty years, only one major firm, Lone Star, has consistently held its market position. All the others have either gained or lost substantially, as shown in Exhibit 2.22.

This is surely not accidental. Nor is it likely that that these patterns of shifting leadership will stabilize or reverse. Those firms which have gained market position have done so by making large investments, and they show every evidence of their interest in continuing to invest. Those firms which have lost position have not increased their investment, and have for the most part reduced their net investment in cement. Their plants are becoming increasingly less competitive, and are almost inevitably being forced to close by the investment pressure of their competitors.

Among the firms with rapid gains in market position are Ideal, General Portland, Kaiser, and Martin-Marietta. These firms may experience some plant closings over the next few years, but those closings are more likely the result of internal demands for expansion and modernization than external competitive pressures or to pollution control legislation.

Among companies with loss of market share are Universal Atlas, Lehigh, Alpha, and Penn Dixie. Of these, Alpha and Penn Dixie seem to be losing position primarily through shutdown of plants. Active pressures to depollute may accelerate the withdrawal of certain plants, but barring a substantial change in investment strategy, most of their plants may well become casualties of competition within a few years. Note that except for Marquette, Alpha and Penn Dixie have the smallest average plant size of the top twenty producers.

EXHIBIT 2.22

MARKET POSITION OF SELECTED COMPANIES, 1950-1970

	<u>Industry Rank</u>		
	<u>1950</u>	<u>1964</u>	<u>1970</u>
Universal Atlas	1	3	3
Lehigh	2	4	9
Lone Star	3	2	2
Ideal	4	1	1
Alpha	5	13	17
Penn Dixie	6	10	11
Marquette	7	8	6
Medusa	8	16	13
General	10	3	4
Kaiser	11	11	8
Martin-Marietta	--	6	5

Marquette has held its market position about stable for the past 20 years, evidently by expanding some plants while closing others. The company's earnings record has not been strong, reflecting most probably the difficult economics of smaller plants. Again, Marquette may suffer some plant closings as a result of antipollution enforcement, but their smaller plants seem to be under severe pressures of competitive economics as well.

Medusa lost position rapidly from 1950 to 1964, and recovered somewhat by 1970. The company has evidently adopted a change in strategy aimed at sustained growth in market position. In 1967, 1968, and 1969 alone Medusa invested \$60 million in new capacity, increasing its total capacity over 50 percent. Medusa may be typical of a firm with apparently high competitive strength whose future growth could be more damaged by pollution control legislation than by competitive pressures. If state or federal actions cause its new plants to be declared insufficiently controlled, even though they were built with then suitable emission control systems, Medusa would have to direct its financial resources to further depollution rather than further growth.

Lehigh Cement has lost market share, but evidently as one element of strategy to improve the long run strength of the company. It has closed down a substantial number of old, small plants and deployed its resources toward upgrading and modernizing others. The serious pollution of these old plants was definitely a factor in their closing, but the primary impetus was recognition of their intrinsically uncompetitive cost structure. Lehigh now ranks in the middle--number ten--in average plant size among the twenty largest producers and seems to be working toward improving that average.

National averages of course obscure individual company competitive strategies to some degree. While it is not within the scope of this study to conduct a complete review of competitive strategy in the cement industry, two patterns serve to suggest the diversity of strategies which can be deduced. General Portland and Kaiser have built huge plants in fast growing market areas. General Portland is the leading producer in Florida, Kaiser leads in California. These companies have risen through a strategy of massively focused investment. Ideal, on the other hand, has built medium sized plants in many rather less densely settled areas. It is the market leader in Montana, Colorado, New Mexico, Utah, Washington, North Carolina, Louisiana, and Oklahoma.

It is our conviction that such differences in strategy and investment behavior, far more than any other factor, will be the important controls over future plant closings. At most, pollution control legislation will increase the cost of a successful strategy, and will hasten the consequences of an unsuccessful strategy.

MERGERS

Most of the cement company acquisitions since 1950 have involved market extension mergers in which the acquisition company extended its operations into new geographic markets by acquisitions. Horizontal mergers within a region have in most cases been classified in violation of Section 7 of the Clayton Act by the Federal Trade Commission.

Since 1950, 34 of the then existing 64 existing portland cement producers have been acquired. More than half (20) of the acquisitions were made by established firms in the industry. The remainder (14) were acquired by firms which had initially entered the industry via merger. Twelve of the mergers in the latter group represented multiple acquisitions by noncement companies like Flintkote, Martin-Marietta, and National Gypsum. All three companies have aggressively pursued active merger programs which secured them a position among the leading 15 firms in the cement industry.

INTEGRATION

All cement firms are backwards integrated into quarrying lime bearing material which is the main raw material. This is principally limestone but oyster shells or marl are also used. Some companies are also integrated forward into the production and distribution of ready-mix concrete and concrete products.

The movement toward forward integration by cement manufacturers began in the late 1950's and early 1960's during the period of large capacity additions. Many established cement producers acquired ready-mixed concrete manufacturers. The Federal Trade Commission has filed several complaints related to the forward-vertical type acquisitions of ready-mixed firms or concrete product manufacturers by cement companies. Most of the cases have been settled by consent decrees. But four complaints involving ready-mixed acquisitions resulted in two required complete divestitures and two partial divestitures.

The chief motive for the forward vertical integration was the creation of captive markets. The FTC believes that vertical integration adversely affects competition in the marketing of cement as well as ready-mixed concrete.* Although such vertical integration has subsequently been disapproved by the Justice Department, many producers still retain these operations. In some cases such as Lone Star and Lehigh, ready-mixed concrete represents a significant fraction of the total sales volume.

Backward integration is an economic necessity, but forward integration is an option, usually attractive for reasons of increased value added, production stabilization, and market expansion. Indeed, a cement business can be usefully regarded as a forward integrated quarry (since quarried limestone itself is a widely used commodity). By moving into ready-mix and precast products, the companies span the distribution chain from extraction (mines) to end use (construction).

Full integration in cement carries with it the usual benefits of flexibility in marketing and high profit potential, and the usual requirements of increased investment and near capacity operation. The experience of the cement industry in forward integration has not, on the whole, been successful. A study of 1956-1969 acquisitions suggests that vertical integration has not improved profitability because it did not provide any foreclosure of markets or economies of integration. In most cases cited, though, operating rates were low and often below the national average. Since high levels of integration characteristically require high operating rates, the problem may lie in the need to change strategy as the firm becomes more integrated, and that apparently was not accomplished.

Since 1950 four cement users, each of them large producers of ready-mixed concrete have integrated backward into the manufacture of cement. In only one instance was integration accomplished through merger; in the other three cases, new cement facilities were built.

DIVERSIFICATION

Traditionally the companies engaged in the manufacture of cement have been single product companies. The last decade,

* FTC: Economic Report on Mergers and Vertical Integration in the Cement Industry, April 1966, pp. 5-6 and 8-9.

however, has seen considerable diversification activity in the industry. Firms engaged in other businesses, such as Flintkote and Martin-Marietta, have entered the cement business. Entirely new companies such as Atlantic and Maule have constructed new cement plants. On the other hand, companies already in the industry have diverted funds from reinvestment in the cement business to a large variety of acquisitions. Some of these ventures are as follows:

<u>Company</u>	<u>Diversification Area</u>
Ideal Basic Industries	Potash
Lone Star	Hawaiian land development, carpeting, U.S. real estate.
General Portland	Real estate development
American Cement	Ski resorts, swimming pools, preengineered metal buildings, aircraft.
Penn-Dixie	Steel, insurance, equipment leasing, real estate development.
Alpha	Shopping center developments, heavy construction
Lehigh	Carpeting, furniture

For the most part these acquisitions have not had a significant effect on the parent company's earnings. In several cases, the acquired firms have performed poorly and adversely affected the parent company's results. Such was the case for Ideal's potash operation and American's resort and aircraft ventures. The failure of these acquisitions to show outstanding results is not surprising. The Boston Consulting Group has demonstrated that market share position relative to competitors in a specific business is the most significant factor in controlling profitability of that business. In each case above, a company with a well established market position in cement, at least on a regional basis,

was diversifying into a marginal market share position in another industry. Even though the industry in which the acquired company was operating may have had a higher growth rate than the cement industry, the unfavorable market share positions of the acquired company made a satisfactory return unlikely.

The trend towards diversification may well proceed much more slowly over the next five to ten years than in the past. As demand growth has brought demand closer to practical capacity, new plant investments will be needed. This is especially true if, as shown by our demand forecast*, cement demand increases at a considerably higher level than the 2.4 percent per year of the last decade. Capital investments for pollution control facilities will also be concentrated in the early 70's. These two drains on capital are likely to restrict the ability of firms in the cement industry to enter other endeavors in the next five years. Offsetting this is a probable improvement in profits over the near term, as prices firm with increasing capacity utilization. Some companies may elect to invest these gains elsewhere, and to relinquish market position in exchange for reduced dependence on cement.

Diversification is attractive, nevertheless, in any company. With cement prices, volume, and profits so closely tied to construction industry cycles, cement companies have a particularly strong motivation to diversify. The declining profits in many cement companies over the last decade reinforce the urge to find alternative uses of funds. New cement plants will undoubtedly become more attractive investment opportunities in the next ten years than they have appeared recently, but it is likely that most companies will prefer to reduce their dependence on cement as the sole or primary source of profits and growth. Whether the diversification trend continues at its past rate or not, it is a safe bet that the pattern of diversification will change. With the unfavorable examples of past diversification in the cement industry (and many others), cement companies will deploy their funds increasingly into businesses where they can achieve market leadership rather than simply unprofitable participation.

* See Exhibit 4.9.

NEW ENTRY INTO THE CEMENT BUSINESS

The rate of entry into the cement business is conditioned by the apparent investment opportunity and availability of capital funds. Cement is a capital intensive, low turnover business. A new three million barrel plant will cost upwards of \$20 million, and a quarry must be found and opened. At best, a new entrant can expect only 70 cents in sales for every \$1.00 invested, with only moderate margins on sales.

Nevertheless, the capital requirements are within the reach of a great many companies. Since equipment and plant design are readily available from the engineering companies, technology is not considered to be a barrier to entry. In the period of 1950 through 1965, 13 firms entered this business.

At present, the industry is approaching its practical capacity. Some regions, such as the Chicago area, are expected to be in short supply as soon as 1972. New capacity has about a two year lead time, so new plant construction will probably begin during the next two to four years. Naturally, present competitors have the manufacturing and marketing know-how which should make them the logical investors. Some will surely add substantial new capacity.

Yet many companies in this industry have been weakened by recent price competition and unfavorable costs. Though the industry overall can probably raise the amount of capital needed for future growth, this is not true for every individual company. Also as we have seen, some firms which could raise the capital to grow will invest in other industries instead. It seems likely, then, that as capacity becomes shorter, new firms with high access to capital will enter the cement business--quite possibly through acquisition of existing companies.

The potential for new entry is tempered by the trends toward increased plant size and increased concentration. New entrants must plan to achieve a large market position. That will require substantial new plant construction, or expansion of acquired plants. A new large plant would very likely cost \$50-\$80 million, perhaps more. The price tag is high, and history suggests that four to six years are typically needed to realize positive cash flow from a new plant investment. This will limit the number of new entrants.

An interesting factor tending toward merger is the depletion allowance on quarry operations. Many less profitable companies do not now get full benefit of their total

allowance, because of their low profitability. Some of these companies may become acquisition targets, in part so those foregone benefits can be utilized.

Section 3

PRODUCTION PROCESS AND POLLUTION CONTROL PROBLEMS

CEMENT PRODUCTION PROCESSES

Portland cement is a material consisting primarily of calcium silicates, aluminates, and aluminoferrates. It is manufactured as a powder of very fine consistency, ranging in color from nearly pure white to dark grey, sometimes approaching black. In the manufacture of cement, lime-bearing material is combined with other ingredients and heated in large rotary kilns to the point of incipient fusion. (In Europe, vertical kilns are still used in a few places, but they are considered an obsolete method.) A chemical reaction takes place, changing the inert raw materials into a substance which, when ground, is highly reactive with water.

The product of the kiln is a grey hard nodular material called "clinker". The clinker is mixed with gypsum, then finely ground in rotating ball mills to form cement. At the time of use, cement is mixed with water and one or more aggregates (soil, sand, gravel, crushed rock, or slag), and the combination hardens into concrete. Concrete is the end product while cement, which generally has no use by itself, is an intermediate product in the making of concrete. Normally, cement is the lowest volume component of concrete, being one-sixth or less of the mix. While it is possible to use cement alone to form the desired solid mass, the aggregates increase the volume, reduce the porosity of the finished product, and lower the cost without loss of strength or durability. The cement in concrete acts both as a binder and as one element of concrete's rock-like character.

Most portland cement is known as grey cement, although a modest amount of white cement is produced. In some senses cement can be classified as an undifferentiated product, with the color range from white to dark grey being the major distinction.

Preceding page blank

The color is controlled by the chemical composition of the cement, and these chemical differences do affect usability in some applications. White cement is used in certain applications where surfaces will be left exposed, for esthetic reasons. There has been some recent trend for architects to specify darker colors as well, which sometimes leads to making special mixes or transporting cement long distances to get a distinctive color produced in a certain region. White cement differs from grey cement in that it does not contain iron. The presence of iron and aluminum in the raw material lowers the heat required for manufacture, so white cement is a more costly product than grey cement. Iron is inert in the finished cement. Aluminum, in addition to aiding in lowered heat requirements, promotes faster setting and high early strength in the cement.

The principal ingredient in the manufacture of cement is a lime-bearing substance. Limestone (calcium carbonate) is the most common but oyster shells or marl may also be used. If limestone is used, it most commonly is obtained from open-pit quarries, although some underground limestone mining is done also. Marl, an earthy mixture of clay and calcium carbonate, is also quarried. Oyster shells are dredged from underwater locations, where ancient beds of oyster shells may be ten feet thick or more. In any case, the raw material is transported to a primary crushing operation where it is reduced by hammer and ball mills into very fine pieces. The fineness of initial grinding is critical in assuring a full chemical combination of the raw materials.

Not all limestone is suitable for cement production, although it is the chemical composition of the stone rather than its purity which controls its usability. Many limestones are high in magnesia, which would result in cements exceeding the allowable specifications for magnesia content. Clay is also in many limestones and is acceptable up to 20 percent since it is another raw material in cement. However, clays and shales can contain alkalies (sodium and potassium) which may result in high alkali cements. This makes many limestone deposits unusable for cement production, because alkalies in cement will react with aggregates thereby producing inferior concrete. Alkali content in cement sold in the U.S. is tightly controlled by A.S.T.M. specifications.

There are two different processes for the manufacture of cement in rotary kilns: wet process and dry process. The distinction is in the mixing of raw materials; otherwise they are identical. In the wet process the finely ground lime material is mixed with other ingredients (usually shale, iron

ore, slag, clay, and silica sand) and blended in a water slurry to be fed into the kiln. In the dry process the ingredients are dried and mixed before they are fed into the kiln. The advantage of the dry process is lower fuel consumption. The advantage of the wet process is that it simplifies the blending of raw materials and ensures a more thorough mixing. About 60 percent of the installed U.S. capacity is wet process.

The raw materials, in either powder or slurry form, are heated to 2700°F. as hot burning gases pass over them in large rotary steel kilns. These kilns may be as much as 22 feet in diameter and 760 feet long. Larger kilns produce more cement, naturally, and are also slightly more efficient users of fuel. Cement kilns are simply rotating cylinders supported at several points and mounted with the axis inclined slightly from the horizontal. They are lined with refractory material to withstand the intense heat, and when operating run day and night, sometimes for months at a time. These kilns are among the largest pieces of machinery used in any industrial process. Raw material is fed into the high end while fuel (powdered coal, oil, or gas) is fed into the low end under forced draft and ignited.

Vast amounts of energy are required in the process. A rule of thumb is that one million BTU of heat are required for one barrel of cement. Some efficient kilns operate with 850 to 900 thousand BTU per barrel, and some older kilns require 1.2 to 1.3 million BTU per barrel. In an effort to lower these heat requirements, the raw materials are sometimes preheated. A kiln so equipped is known as a preheater kiln. Although energy requirements are lower for a preheater kiln, these systems can lead to higher alkali content in the cement; they are not widely used in the United States. Wet process kilns require more heat than comparably sized dry process kilns, to vaporize the water from the slurry.

As the materials move through the kiln, chemical reactions take place. Certain gases, principally carbon dioxide and combined water, are driven off and the remaining material unites to form a new substance with different chemical and physical properties. This substance, clinker, is discharged in pieces about the size of marbles from the low end of the kiln. The clinker is cooled by air blowing through it while it passes on a moving bed. Gypsum is added and the mixture is reground to extreme fineness. More than 80 percent of the finished product, now called portland cement, will fit through a mesh with 100,000 openings per square inch. The finished cement is stored in large silos and is transferred from these to bulk carriers such as trucks or railway cars, or is bagged for shipment.

The properties of the finished cement are closely regulated by the American Society for Testing and Materials. These regulations govern the composition, fineness of grind, setting time, strength, and other characteristics. Each company's cement of a given type meets these specifications and the products produced by the various companies are similar, though not quite identical. By varying the inputs and operating characteristics of the kiln, a company can produce several types of cement.

There are about ten different types of cement, but just three varieties constitute over 97 percent of all production.

	<u>Type</u>	<u>% of U.S. Production</u>
I and II	General Use & Moderate Heat	93.7
III	High Early Strength	3.6
	Oil Well	.6
V	Sulfate Resisting	.7
	White	.4
	All others	1.0
		<u>100.0</u>

Usually a single construction job with exposed surfaces uses cement from a single kiln, for uniformity if not eye appeal. Interestingly, despite the relatively undifferentiated nature of the product, local tastes or habits make users unwilling to buy cement of a color different from that regularly produced in that region. Such preference patterns appear to be one barrier in building giant plants to serve a very wide area. At any price, the unfamiliar cement simply cannot be sold--or at least that is what numerous cement executives feel. In the main, of course, transportation costs rather than color control the effective marketing area of a plant.

POLLUTION IN THE CEMENT INDUSTRY

The pollution problems of the cement industry arise from two principal sources. The first is the escape of dust into the atmosphere; the second is water pollution caused by the discharge of highly alkaline solutions into ground or

surface water supplies. The dust is picked up by the gas stream in the kiln during the formation of clinker and in the clinker cooler. There is no known way to suppress the generation of dust in this process, so it must be precipitated or filtered from the exhaust. Liquid pollutants come primarily from dust leaching, either by rain if the dust is discarded or exhausted, or in leaching tanks if the dust is deliberately leached for recycling into the kiln. Minor water pollution is caused by plant clean-up, thermal pollution (bearing water, compressor cooling), and sometimes sanitary wash.

The cement dust which presents the air pollution problem is nontoxic, noncorrosive, nonflammable and nonexplosive. So far as is known it is not hazardous to health, except, as any dust, in extreme concentrations. In fact, because of the alkali content, the dust makes excellent liming products for agricultural purposes. The dust is very fine, however, and is emitted in suspension with a high temperature, high volume air stream. The dust is carried aloft by the heated air and can be scattered over a wide area downwind of the plant. If unsuppressed, it has the effect of producing a greyish coating on plants and buildings.

Little is known about the potential health hazard, if any, of cement dust. There have been two suits brought against cement companies for health damage done to workers, but both were decided in favor of the companies. It is known that most dust particles larger than one micron are removed in the nasopharyngeal tract. A large portion of particles smaller than one micron are deposited in the bronchial and pulmonary regions, where their effect is unknown. These very fine particles are known to have the highest concentration of alkalis, but these alkalis are converted into inert salts by the action of carbon dioxide. As cement plants improve their control of dust emissions, the small amounts released are naturally composed primarily of the very finest particles. A great deal of research must be done before it can be said with any certainty whether these very diffuse concentrations of submicron particles create any form of health hazard, or to what extent they may pose a hazard.

Within a cement plant there are several significant sources of dust. By far the most important is the kiln. As vast quantities of very hot air are drawn through the kiln, quantities of dust are picked up in the air stream. The other principal sources of dust emissions are the clinker cooler and raw material dryer (dry process only). In both cases air is being blown through material which contains some fines, and a certain amount becomes suspended in the air stream.

Because of the very fine nature of the product, dust is also given off in the course of grinding and loading as well as at transfer points in the production process. The amount of this dust is much smaller. Control of inplant areas is often required for occupational health and production efficiency reasons. Dust emission from these sources is usually localized to the immediate vicinity of the plant since the emissions are at ground level and are not borne aloft by hot air.

The two devices used for removing the dust from the air stream are "bag houses" or more properly, bag collectors, and electrostatic precipitators. (See Exhibits 3.1 and 3.2.) Bag collectors are structures containing large numbers of tubular fabric "bags". The dust-laden air is blown or drawn into the bag house, where it passes through the bags which filter out the dust. (Gas passing through these tubes is exhausted, often appearing as a white plume as water vapor condenses.) If this treatment is used the dust is mixed without regard to particle size when the bag is collapsed to free the collected dust. The dust falls and is collected in the hoppers at the base of the bag house. The filtering is not done by the bag itself, but by the dust cake formed on the fabric, much as a household vacuum cleaner functions.

Precipitators are structures with large numbers of electrically charged wires and grounded plates over which dust-laden air passes. The dust particles pick up an electric charge, and are then attracted to the plates. The plates are "tapped" periodically to shake the dust downward. The dust is not shaken loose from the plate, as it would become re-entrained in the air stream; instead, the tapping makes it slide down. Because the larger particles stick to the plates closest to the air inlet, the dust particles can be stratified by size. This factor is important as the alkali particles, which cannot be recycled into the kiln, tend to be small. These can be separated out more easily in a precipitator for separate disposal.

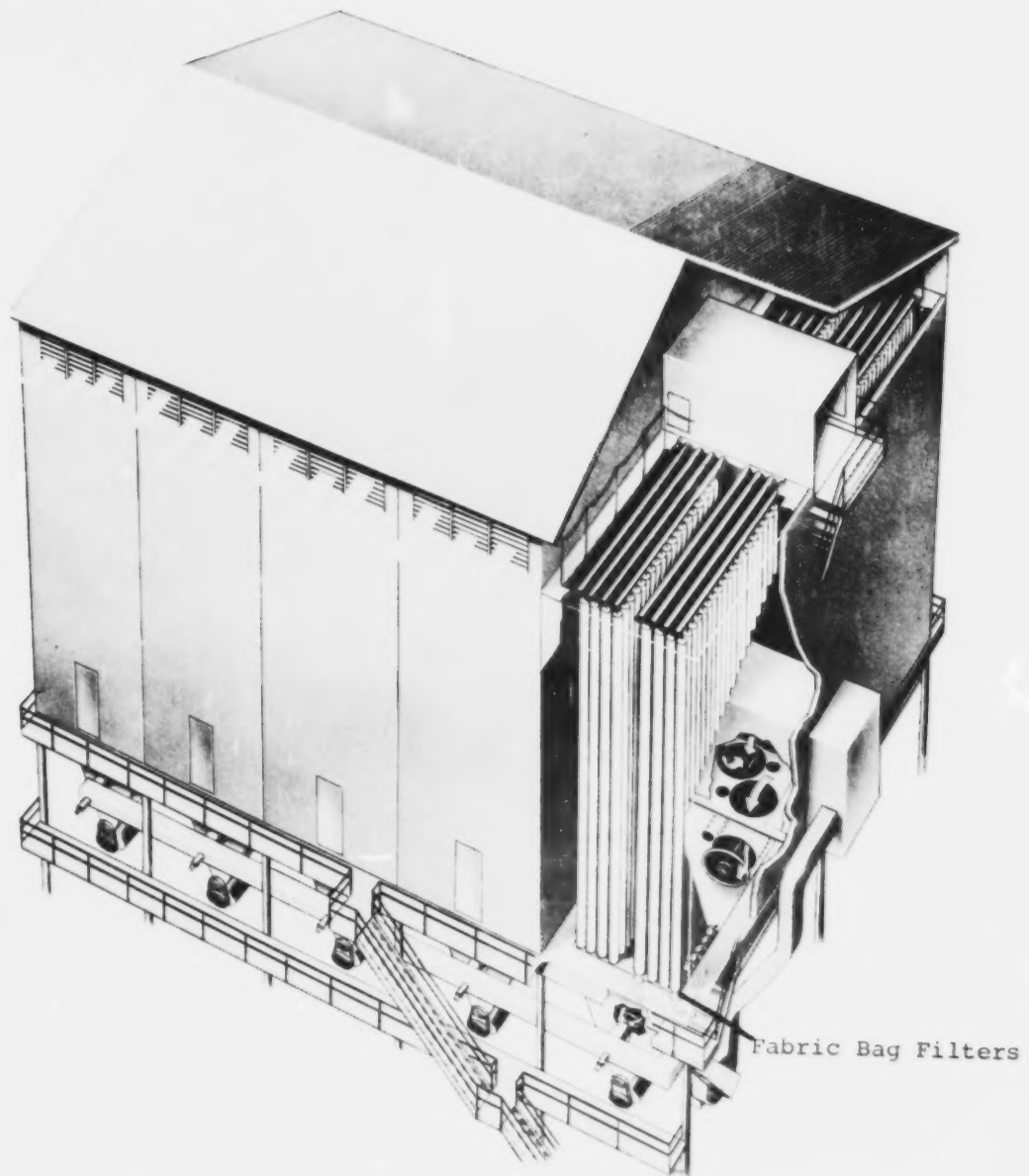
The amount of dust produced, before recycling, averaged 11.3 percent and 10.1 percent finished clinker weight (dry and wet processes) in a cross section of plants.*

*Source: Atmosphere Emissions From the Manufacture of Portland Cement, U.S. Department of Health, Education, and Welfare, 1967.

-55-

EXHIBIT 3.1

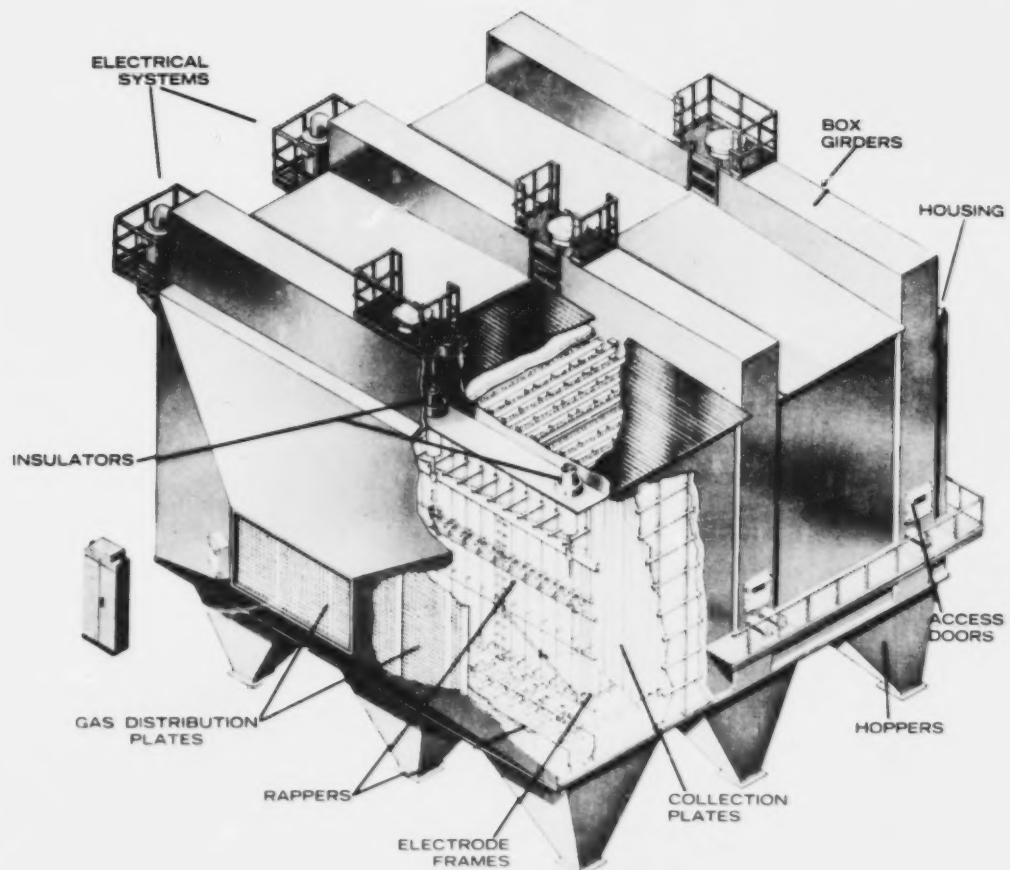
BAG HOUSE



Source: Wheelabrator Corporation

The Boston Consulting Group, Inc.

EXHIBIT 3.2
PRECIPITATOR



Source: Wheelabrator Corporation

The dust from the clinker cooler and raw material dryer is controlled by bag collectors or precipitators. Wet process kiln dust is usually scavenged by electrostatic precipitators. The electrical resistivity of the dust in the moisture-laden air from a wet process kiln lends itself to precipitator use. Dry process kiln dust is usually removed by a fabric bag house or conditioned with water for removal by precipitators. Precipitators are usually less costly than bag houses for equivalent air flow and have lower operating costs. They also give some grading to the dust, as noted above. One of the chief cost differences is the driving fans required; bag houses create a substantial pressure drop, not experienced in precipitators.

The dust removed by either system is subjected to further treatment. Fortunately, most of the dust which is removed can be recycled back into the kiln. The value added by this recovered material partially offsets the cost of the collection device. If the raw material has a low alkali content, the dust may be reinjected into the kiln feed for transformation into cement. In the wet process, the salvaged dust is reinjected at the fuel supply end of the kiln.

Some dust inevitably can not be reintroduced into the kiln; it has too high an alkali content. Occasionally such dust is sold for agricultural liming uses or as asphalt filler. Normally that is impractical due to highly seasonal demand and to the cost of storage and handling. Yet the volume of salvaged dust is high, sometimes several hundred tons per day. Some companies simply haul the dust back to their quarry, wet it down, and allow it to harden. Some companies process it through leaching tanks, where the dust is dumped into water tanks. The soluble alkalies go into the water, and the solid material can be salvaged and reintroduced into the kiln. Although leaching pits save raw material, they are costly to operate and create a water disposal problem.

If the dust is stored in an open pile, or conveyed back to the quarry, the soluble alkali may be leached out by rain or groundwater and enter the ground or surface water. This alkali leaching, intentional or natural, is the principal source of water pollution in the cement industry. However, there is some potential benefit to this. Most industrial waste water pollutants are acidic, and cement alkali can restore a more normal pH to water supplies.

Another attempt to solve the dust disposal problem is currently being made, utilizing a new cement manufacturing process called the Pyzel process. Dust from the precipitator

or bag house is used as a raw material for a fluid bed reactor where the dust "floats" on an upwelling of heated gases. The alkalis are vaporized and given off as gases. The remaining dust is transformed into cement clinker. Recovery of the gaseous alkali is possible through precipitation. Because the volume of unusable, high alkali material is so much lower, disposal is not a serious problem. The recovered cement (about 10 percent of total plant capacity) would partially offset the cost of the additional equipment. Installation costs are presently estimated to be \$10/barrel, considerably higher than rotary kilns (\$4/barrel in a large plant, \$6/barrel in a small plant). Operating cost per barrel for the Pyzel Kiln is slightly lower than for rotary kilns since less fuel is required. This process has been tried in a pilot plant (3' reactor) by the Fuller Company, Catasauqua, Pennsylvania, which holds patent rights in cooperation with the Atlantic Cement Company. It is not yet known if a scaled up model would be successful.

The clinker produced in a Pyzel reactor is considerably smaller than that from a rotary kiln, in this case, about the size of BB's or buckshot. It is considered by some people to be easier to grind, and to produce a higher quality cement because of high early strength of the eventual concrete. Whether this would be so on a commercial scale, or if so whether it would command a better price, is not known.

The elimination of quarrying and raw material grinding cost for recycled dust entering the Pyzel kiln would save about 57 cents/barrel over the cost of cement produced in rotary kilns from freshly quarried material. An industry source has indicated that the \$10/barrel capital cost would greatly discourage interest in this process. While mass production of these devices would reduce costs, the commercial future of this process is highly uncertain because of the high initial outlay.

The Pyzel process seems to be at this time an impractical primary method for making cement, as an alternative to burning in kilns. However, it has great appeal as a disposal system for conventional plant pollutants, in that it assures virtually complete conversion of raw materials into finished products or harmless by-products. Without such a system as this, cement plants will always have a substantial disposal problem even if pollution problems are totally conquered.

The cement manufacturing process also produces pollutants other than the dust and alkali. Primarily these are

water vapor, carbon dioxide, and nitrogen oxides. By far the largest of these is carbon dioxide, since approximately one-third of the raw limestone is driven off as carbon dioxide in the conversion to cement. Neither water vapor nor carbon dioxide are now considered harmful pollutants. Nitrous oxides, and sulfur oxides which could be emitted if sulfur is present in fuel material, may be harmful pollutants. However, there are no proposed standards for these pollutants, nor is there any convenient way to measure them. Sulfur and nitrogen oxides combine readily with the alkaline dust, so much smaller amounts of these gases than those theoretically possible are emitted. Most of them probably emerge either in harmless combined forms, or are trapped with the dust and thereby disposed of.

LEVEL OF CONTROL AND INDUSTRY IMPACT

As the desired level of pollution control rises, the cost of control tends to rise more quickly. This is represented graphically in Exhibit 3.3.

Marginal increases in control level may be very costly to obtain and may serve to make implementation of the program more difficult. Impacts are considerably more severe at very high levels of control where costs rise sharply. This is especially true in the case of older plants. Whereas upgrading of control facilities might be possible for certain control levels, entirely new facilities are necessary for higher levels of control. Control costs are discussed in more detail in a later section.

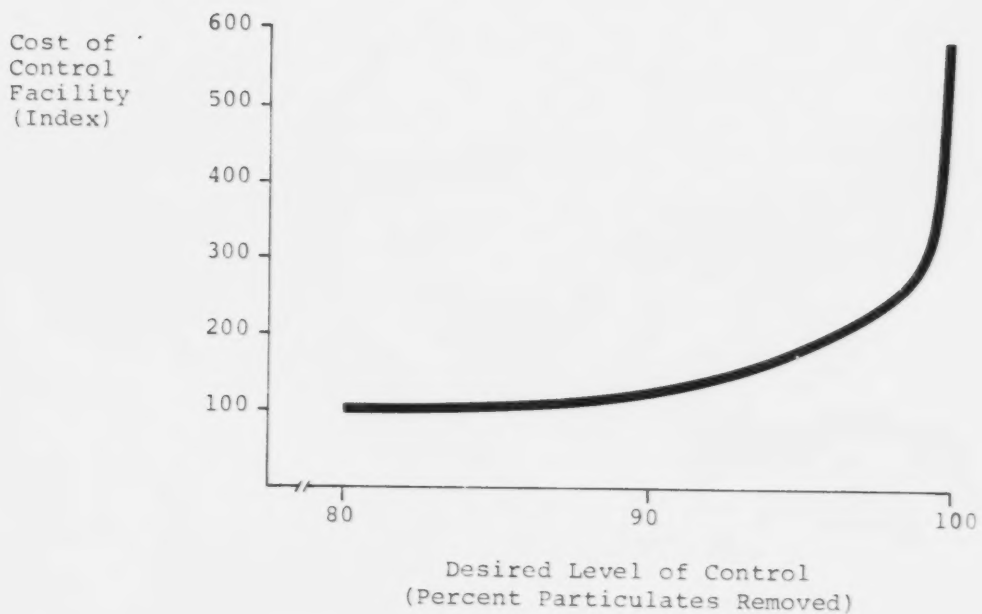
All plants are controlled to some degree now. The following table shows figures supplied by the Environmental Protection Agency, which summarizes the estimated levels of control as of 1967.

ROTARY KILNS

<u>% of Plants</u>	<u>Control Efficiency (% of Particulates Removed)</u>
20	99
10	97 - 99.5
10	95 - 97

EXHIBIT 3.3

TYPICAL RELATIONSHIP OF
CONTROL COST Vs. LEVEL OF CONTROL



Percent Particulates Removed (by weight)	Total Cost of Control	Incremental Cost per 1 Percent Incremental Control
80%	100	1.25
96	200	6.25
99.2	300	31.25
99.84	400	156.25
99.968	500	781.25

ROTARY KILNS (CON'T)

<u>% of Plants</u>	<u>Control Efficiency (% of Particulates Removed)</u>
10	93 - 95
10	90 - 93
40	75 - 90
<u>100%</u>	

CLINKER COOLERS

all	91.5% average
-----	---------------

RAW MATERIAL DRYERS

50%	96 - 98
50	90 - 96
<u>100%</u>	

Plants built between 1967 and 1971 are generally equipped with high levels of control equipment. These are assumed by the E.P.A. to meet any federal standards for existing plants which might be adopted. Individuals in industry have contended that this is not the case. In their view, the states are likely to adopt standards for existing plants which are identical to the federal standards for new plants. If this happens, plants built between 1968 and 1971 would, in their opinion, require substantial additional investment to attain the required emission levels.

POLLUTION CONTROL STANDARDS

The potential economic impact of varying standards is of great concern to the industry. After a good faith attempt to comply with federal, state, or local standards, subsequent more stringent standards might require entirely new equipment. The design of precipitators and bag houses often precludes the addition of extra dust removal capability in a control facility after the initial installation. This is especially true in older installations where space limitations are often crucial. It is impractical to provide space and mechanisms for future expansion of the control equipment, or to depollute to a level adequate for any potential standards. Both cost too much.

Sometimes the fear of constantly changing standards has delayed action. Rather than push with compliance to a standard, only to have the pollution control equipment rendered inadequate by a more stringent standard, some companies have deferred any expenditure until a final standard is arrived at. In the meantime, their competitors who voluntarily installed controls operate at an economic disadvantage, and may incur a further disadvantage if their controls are later declared inadequate.

Uniform federal standards will help correct this situation and induce more rapid compliance. The same is true of an indication on the state and local level that the standards in effect, however stringent they might be, will be maintained for a reasonable period of time. It is important to remove as much of the uncertainty as possible from the level of control which will be required now and in the foreseeable future. This will permit responsible companies to proceed with control plans with the assurance that their dispatch at attempting compliance will not be penalized by a changed standard a short time later. If standards are constantly changing, the company which delays the most is rewarded by being able to comply with a final standard rather than making expenditures on equipment which a later standard renders inadequate.

The effect of uncertain pollution controls standards has evidently also been to reduce the rate of new plant investment. Little new capacity has been started since 1967, apparently in part through apprehension about the cost of adding additional controls to a new plant. The consequence has been that the industry has operated nearer its rated capacity, and prices have gone up correspondingly--by about 20 cents per barrel in 1971. Current price controls may restrict further price increases, but it is probably no coincidence that the decline in new plant construction was correlated with an accelerated growth of imports and increased U.S. prices were associated with rising imports.

A healthy industry requires a high rate of investment. As we shall show later, strict pollution control regulations will increase the rate of investment in cement-producing facilities, with overall favorable impacts. During the past few years, it seems fair to say, the uncertainty about state and federal controls has inhibited investment, which may have contributed to higher prices, higher costs, and loss of market to imports.

NEW PLANT STANDARDS VERSUS EXISTING PLANT STANDARDS

The federal government has proposed emission standards to be applied only to new plants built after the effective date of the standards. The states are in the process of adopting emission standards which will apply to existing plants to bring them into conformance with federal ambient air standards. As stated earlier, individuals in the industry have expressed concern that the states will adopt emission standards for existing plants which are identical to federal standards for new plants. For older plants in particular, it would be extremely difficult, if not impossible, to meet emission standards which a newly constructed plant can reasonably be expected to attain. If states require all plants to meet new plant standards, a large number of plants will close down which would otherwise operate for many years to come.

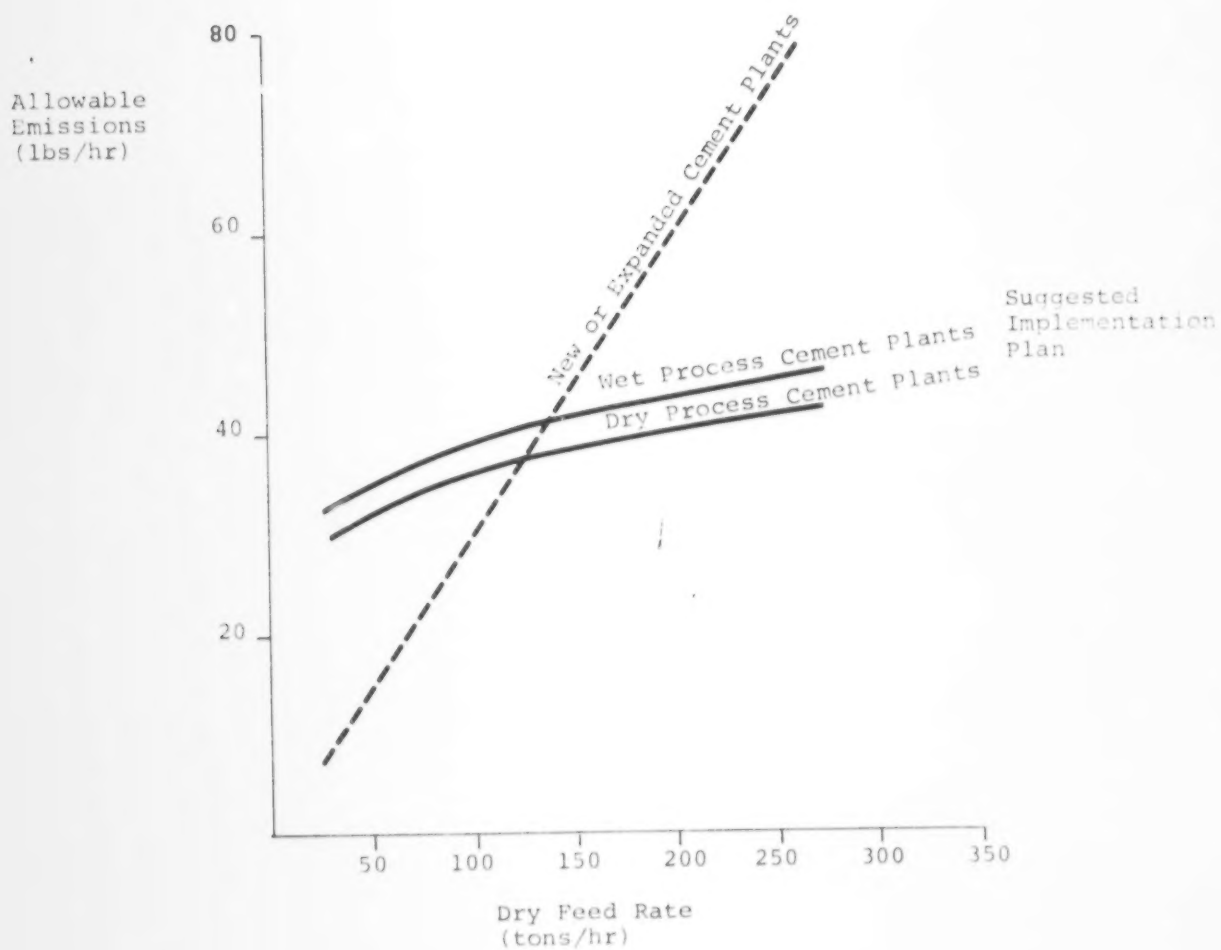
An evaluation of the cost impact of pollution controls (revised October 8, 1971), provided by the Environmental Protection Agency, stated that plants built between 1967 and 1971 could be expected to already meet ambient air quality requirements for existing plants. If all existing plants had to be controlled to the degree described in the new plant emission standards, the impact would be considerably greater than if the existing plants had to be controlled to the level of the average plant built between 1967-1971. Although these new plants (1967-1971) are controlled to a high degree, as stated in the E.P.A. draft, they will generally not meet the proposed new plant standards.

As previously discussed, cost rises rapidly to attain the marginal additional level of control above 99 percent particulate removal. While the difference between the 1967-1971 plant levels and the proposed new plant standards may not be large, the marginal cost to existing plants of upgrading to new plant standards will be significantly more costly, if it is even feasible, than the cost of upgrading to control levels of the average 1967-1971 plant.

Exhibit 3.4 illustrates the difference between federal new plant emission standards and the federally recommended standards for implementing ambient air quality standards in existing plants. The impact of these standards is clearly quite different. New small plants must be much more tightly controlled than old small plants; but large new plants are allowed more emissions than large old plants.

EXHIBIT 3.4

COMPARISON OF FEDERAL NEW SOURCE
STANDARDS WITH SUGGESTED PROCESS WEIGHT TABLE



Source: Ideal Cement Company

About two-thirds of U.S. plants fall below (i.e., to the left of) the crossover point on the chart. In other words, for those plants the implementation plan is more lenient than the new plant standards. But if one of those old plants were rebuilt, it would be more advantageous to expand its capacity, since at the former small capacity it would have to meet stricter standards than a corresponding small plant not rebuilt. Conversely, a newly built large plant faces less severe pollution control requirements than an existing plant of comparable size. If the states largely adopt the recommended standards for existing plants, it will have the effect of encouraging the construction of large new plants and of expanding substantially existing plants.

There is no exact conversion between dry feed rate per hour and annual barrels per year of capacity, because a kiln cannot run full time. From time to time kilns are shut down as a result of weather, maintenance, or market conditions. The theoretical conversion of hours/year x tons/hour x barrels/ton is $29,170 \times \text{tons/hour} = \text{barrels/year}$. A 100 ton/hour plant is therefore about a three million barrel facility. The crossover point on Exhibit 3.4 occurs at about 3.65 million barrels.

There appears to be a difference in the federal and some state interpretations of the suggested implementation plan standards. The federal interpretation is that a 150 ton/hour dry process plant would be allowed to emit 38.5 pounds of particulates per hour. That would be the limit regardless of the number of kilns. But under some state interpretations, if that plant consisted of three 50 ton/hour kilns, the allowable emissions would be 3×34.5 , or 103.5 pounds/hour. The enforcement on a per-kiln or per-plant basis makes a great deal of difference in the amount of control equipment required, and evidently requires some clarification.

MEASUREMENT METHOD

Measurement of emission levels poses a difficult problem. Many states have stack plume opacity standards as one index of pollution. Since stack gas contains a good deal of water vapor, it may have considerable opacity under certain atmospheric conditions, though the plume is virtually devoid of particulates. Public opinion, too, may consider a plant a polluter because of a stack plume even though the plume may be only vapor condensation.

A more serious measurement problem is that of measuring bag collector output. Many bag houses are built such that a large volume of surrounding air is drawn into the bag house on the exhaust, or clean, side of the bags. This contributes to efficient operation and cools the exhaust gases before they are released to the atmosphere. This mixed volume of air is discharged through openings under the eaves of the structure. This opening may be 100 feet long and a foot or so high, on both sides of the building. There is no established technique for sampling such a stream to provide a reliable index of particulate content.

In addition to establishing firm and reasonable standards, it is important that sound and reliable measurement techniques be specified. In the absence of measurement technology, companies otherwise willing to comply may delay their investment.

Section 4

MARKET STRUCTURE AND DISTRIBUTION

PRODUCT MARKETS

Total U.S. cement shipments (including Puerto Rico) reached a record level of \$1.38 billion in 1969 and declined in 1970 by \$16 million. (See table below.)

COMPOSITION OF DOMESTIC CEMENT SHIPMENTS
(1969 and 1970)

	1969		1970	
	\$ Million	Percent	\$ Million	Percent
Portland Cement	1,313	95%	1,298	95%
Masonry Cement	69	5	68	5
Natural Slag and Hydraulic-Lime Cement	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>
Total	1,382	100%	1,366	100%

N = negligible

Source: Bureau of Mines - 1969 Yearbook

- 1970 Preliminary Data*

Portland cement can be further classified into finer product categories. Among nine generally available product types, general use cement and moderate heat cement (types I and II) account for 92 percent.

* 1970 data were obtained from yet unpublished Bureau of Mines compilations.

Data in this report focus primarily on the portland cement industry, which has consistently in the past maintained a 95 percent share of the total dollar shipments of all cement.

After World War II the construction industry in the U.S. expanded sharply causing sustained growth in the production and consumption of portland cement. Between 1947 and 1955 cement shipments increased at an annual rate of six percent reflecting a postwar demand for concrete-using facilities such as shopping centers and airport runways.

The very high operating rate of the middle 1950's created a situation in which the cement industry return on equity rose to 15-20 percent, among the highest of any industry group. This appealing environment stimulated major capacity additions beginning in 1956 at a time when the market growth began to slow down substantially. During the period of 1956 to 1962 capacity grew about five times as fast as production. In the early 60's the operating rate consequently declined to around three-fourths of capacity causing a major problem for the industry. Profits dropped sharply and remained low as new construction grew almost as fast as demand. In the past two years the situation has improved. The operating rate has reversed and average mill prices have grown correspondingly. (See Exhibit 4.1.)

In 1970, domestic cement shipments declined in volume. Shipments were estimated to be about 380 million barrels or five percent below the 1969 level. (See table below.)

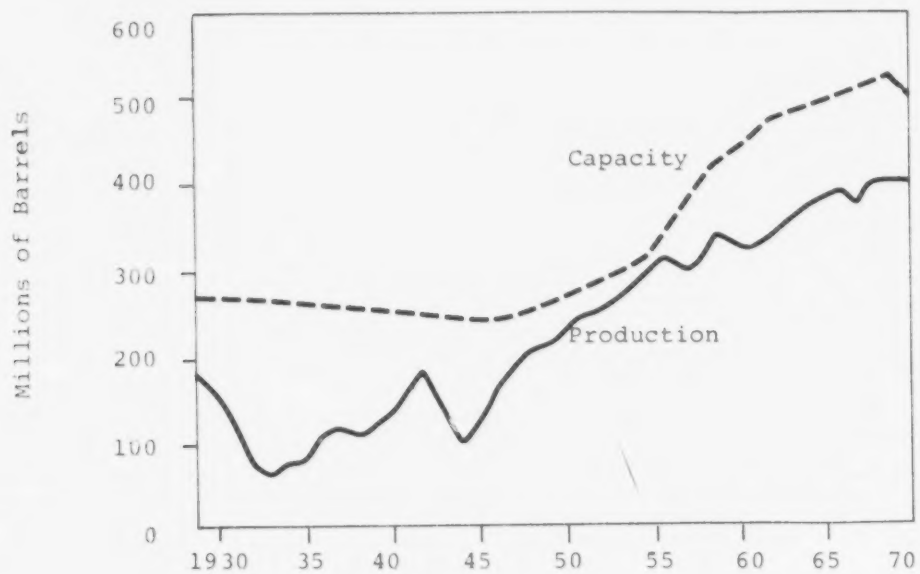
U.S. DATA ON PORTLAND CEMENT*
(In Million Barrels)

	<u>1955</u>	<u>1960</u>	<u>1965</u>	<u>1969</u>	<u>1970</u>
Production	298	319	371	400	389
Capacity	315	433	482	512	
Operating Rate	94%	74%	77%	78%	
Domestic Shipments	293	312	374	410	390
Net Imports	3	4	5	9	13
Total Consumption	296	316	379	419	403
Average Price (per bbl.)	\$2.86	\$3.35	\$3.15	\$3.20	\$3.32

* includes Puerto Rico

Source: Bureau of Mines
 . 1970 figures are preliminary
 . At the time of this study capacity figures had not been compiled

EXHIBIT 4.1
PORTLAND CEMENT CAPACITY AND PRODUCTION, 1929-1969



GEOGRAPHIC MARKETS

Cement markets are local and regional because the low value, weight, and bulkiness make nationwide shipments very costly. It is usually better to build a plant close to the point of use (assuming suitable limestone is available), in order to reduce freight charges. Exhibit 4.2 shows regional consumption and growth trends. Exhibit 4.3 shows these data on a map of the United States. Note that the Southern region has been both the largest and the fastest growing area for cement use.

A further detailing by states identifies particular patterns of supply-demand characteristics. Local cement markets do not always correspond to well defined state borders, but widespread data are available only on a state-by-state basis. Exhibit 4.4 identifies supply-demand characteristics for the ten largest cement-producing states, which in the aggregate provide 66 percent of total U.S. capacity. The exhibit also shows what proportion of each state's production is exported or imported, i.e., shipped interstate. Pennsylvania, for example, exports a large proportion of its output, and so prices in Pennsylvania are strongly affected by demand not only in Pennsylvania but other states as well. One observes a relationship between the degree of export and import dependence and the prevailing mill price in each state. High export states suffer low prices, and importing states have high prices.

Pennsylvania, New York and Alabama are large net exporting areas with prices in all three states being significantly lower than the national average, reflecting a highly competitive environment.

Cement plants in these markets have to look aggressively for net importing areas like New England, Ohio, New Jersey and Florida. They are not only competing domestically but also have to compete against foreign imports. Relatively low priced imports from the Bahamas penetrate the New York City and the Florida area. Canadian cement is shipped into Ohio, New York and Maine, and even shipments from Norway enter the U.S. East Coast keeping prices lower than in other parts of the country.

Even though operating rates will probably improve in the next few years, the continued pressure from imports will maintain stringent competitive conditions in these three states. Marginal plants in these regions will continue to close.

EXHIBIT 4.2

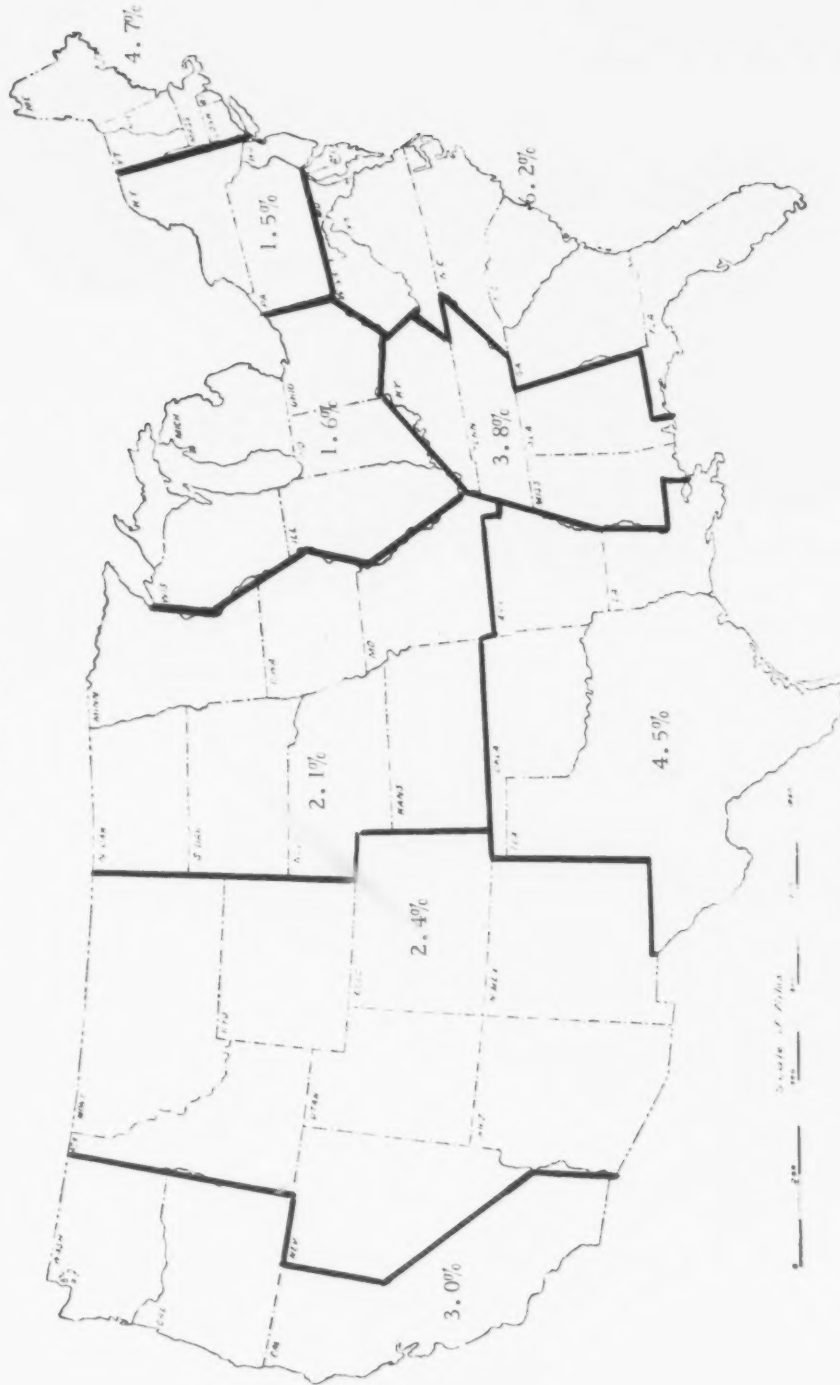
GEOGRAPHICAL COMPOSITION OF PORTLAND CEMENT CONSUMPTION*
(Million Barrels)

	<u>1960</u>	<u>1969</u>	<u>Annual Compound Growth Rate</u>
North East Region	52.1	63.6	2.2%
New England Division	10.0	15.2	4.7%
Middle Atlantic Division	42.1	48.4	1.5
North Central Region	99.0	115.6	1.3
East North Central Division	65.3	75.4	1.6
West North Central Division	33.7	40.2	2.1
South Region	93.6	146.6	5.2
South Atlantic Division	41.4	70.3	6.2
East South Central Division	16.7	23.4	3.8
West South Central Division	35.5	52.9	4.5
West Region	63.0	80.7	2.8
Mountain Division	17.8	21.9	2.4
Pacific Division	45.2	58.8	3.0
Total	307.7	406.5	3.2%

Note: *Consumption is approximated by shipments from U.S. mills because import data are only available by customs district and not by final destination.

Source: Bureau of Mines
Excludes Puerto Rico

EXHIBIT 4.3
GEOGRAPHICAL COMPOSITION OF ANNUAL GROWTH RATES
OF PORTLAND CEMENT CONSUMPTION
1960-1969



National Average 3.2%

EXHIBIT 4.4

1969 MARKET INFORMATION ABOUT 10 LARGEST STATES
RANKED BY CAPACITY
(Million Bbl.)

	Capacity	Production	Capacity Utilization	Consumption 1960	Consumption 1969	Annual Compound Growth	Prices ² per bbl.	Export or ³ (Import)
1. California	60.3	50.7	85%	35.3	46.5	3.1%	3.36	8% EX
2. Pennsylvania	52.3	43.1	83%	13.7	19.8	4.1% { East West	2.70 3.12	54% EX
3. Texas	46.2	35.8	78%	20.2	30.1	4.6%	3.27	16% EX
4. Michigan	41.1	30.5	74%	13.9	16.5	2.0%	3.24	46% EX
5. New York	33.0	25.7	78%	20.4	17.6	-1.5%	2.62	31% EX
6. Missouri	30.4	20.9	70%	7.7	9.6	2.4%	3.32	54% EX
7. Indiana	21.7	16.1	73%	8.8	9.5	.9%	3.17	41% EX
8. Ohio	20.2	14.7	75%	17.1	20.2	1.9%	3.32	(37%) IM
9. Alabama	16.5	13.3	77%	4.6	6.0	3.0%	3.10	55% EX
10. Florida	14.2	9.9	71%	12.1	18.7	4.5%	3.40	(89%) IM
U.S. Total ¹	335.9	260.7		153.8	194.5			
National average:	512	399.6	79%	307.7	410.6	3.2%	\$3.20	
Sum of 10 states	667	65%		50%	47%			
U.S. Total								

Notes: ¹including Puerto Rico
²mill price (fob)
less discounts
less transportation
³consumption-production
production

Source: Bureau of Mines

APPLICATION MARKETS

Cement is sold to five types of customers.

- A. Ready-mixed concrete manufacturers
- B. Concrete products manufacturers
- C. Contractors
- D. Building materials dealers
- E. Others

The mix of sales in these markets is slowly changing, as illustrated in Exhibit 4.5.

Increasingly, cement is purchased by ready-mix and concrete products manufacturers. Ready-mix contractors are extending their services as more contractors stop making their own concrete at the construction site. With construction labor costs rising rapidly there is also a trend toward more use of prefabricated concrete products.

Since ready-mixed concrete manufacturers account for a major portion of cement shipments, the components of their use are given in more detail in Exhibit 4.6.

GOVERNMENT INFLUENCE ON MARKETS AND PRODUCERS

Government influence on the cement industry includes both demand and policy effects. The federal and state governments purchase very little cement directly, but they control a great deal of construction spending which utilizes almost half the cement produced. Exhibit 4.7 shows the division of end uses of cement between public and private sectors.

Most of the actual spending for roads, public works, and public buildings is done by states, counties, and municipalities. Yet a large fraction is in part federally funded, or is related to federally funded activity. Perhaps the dominant examples are the federal highway program and the various urban renewal programs. The federal government has a large degree of flexibility in setting the pace for these activities, and so will influence cement production quite substantially in that way.

EXHIBIT 4.5
CEMENT SHIPMENT BY TYPES OF CUSTOMERS*

	<u>1962</u>	<u>Percent</u>	<u>1969</u>	<u>Percent</u>	<u>Annual Compound Growth</u>
A	190.5	57.4	247.0	60.3	3.8%
B	42.7	12.9	55.2	13.5	3.8
C	50.9	15.3	55.5	13.5	1.2
*Highway	37.5	11.3	39.3	9.6	.6
*Other	13.4	4.0	16.2	3.9	2.7
D	37.0	11.2	33.1	8.2	-1.4
E	10.6	3.2	18.8	4.5	8.6
*Govern- ment	4.3	1.3	3.0	.7	-4.7
*Misc.	6.3	1.9	15.8	3.8	14.0
Total	331.7	100%	410.0,	100%	3.1%

Source: Bureau of Mines

EXHIBIT 4.6

COMPOSITION OF CEMENT CONSUMPTION BY
CUSTOMERS AND END USE MARKETS, 1969

		Percent of Cement Shipments
A - Ready mixed concrete manufacturers	60%	
* Home Building		22%
* Commercial Construction		12
* Industrial "		8
* Highway "		7
* Public Works		6
Others		5
B - Concrete Product Manufacturers	13%	
* Block		5
* Pipe		4
* Prestressed		2
* Pre cast		2
C - Contractors	14%	
* Highways		10
* Others		4
D - Building Material Dealers	8%	
* Consumers		4
* Builders & Contractors		3
* Industry		1
E - Others	5%	
* Governmental Agencies		1
* Miscellaneous		4
Total	100%	

Source: The Boston Consulting Group Estimates

EXHIBIT 4.7

PORTLAND CEMENT CONSUMPTION BY PUBLIC
AND PRIVATE END USE MARKETS - 1969

PUBLIC	46%	
- Street and Highways		20%
- Public Works		14
- Public Buildings		12
PRIVATE	54%	
- Residential Construction		24
· single family		13
· multi family		11
- Industrial and Commercial Construction		20
- Farm		4
- Miscellaneous		6
TOTAL	100%	

Source: The Boston Consulting Group estimates

Yet the federal government has even more influence on cement demand than its more or less direct role in public construction projects. The largest single area of cement demand, almost one-fourth of all output, is for residential construction. Currently about one-third of all residential units built are in some way federally funded, through such programs as Section 221 (d) (3) multifamily housing, and Sections 235 and 236 subsidies for construction and rent/mortgage payments. Such programs as these not only contribute to the quality of life of their direct beneficiaries, but through stimulating construction activity, they also accelerate the demand for cement.

A great deal of construction, while not directly stimulated by the government, is the consequence of one or another federal program. As government steps up its purchases of manufactured goods, factories and facilities must be provided. Since the federal government is the largest single purchaser of goods and services, it seems fair to conclude that much of U.S. industrial and commercial construction has been affected by, if not directly responding to, government policy and action.

There is substantial government influence over agriculture as well in this nation. Although farms are a small sector of cement use (about four percent), government policies affecting farm income will also influence farm construction.

It is not unreasonable to estimate that the federal government has some degree of influence or control over at least 75 percent of end uses of cement in this country. This is not to suggest, of course, that the government could increase or reduce demand by 75 percent (either of which would be a catastrophe for the industry). Much of this construction would be completed even if the government were totally absent. The major effects of government action seem to be an influence over the total amount of construction, and an acceleration or retardation of the timing of construction. Yet this is vital. The cement industry has a high degree of operating leverage. The break-even point of a cement plant is typically 70-75 percent of full output. Small changes in operating rate and product price lead to substantial swings in profitability.

The government's ability to stimulate or inhibit construction is a potent influence on the cement industry, and is perhaps the single most powerful control over the industry. The control points include not only the more or less direct areas of public construction and federally aided private construction, but such indirect controls as interest rates, investment credits, and tax policies.

Interestingly, although the government has a massive influence on the cement industry, it is not a selective influence. Cement use, as we have seen, is derived from construction demand. For the government to stimulate or inhibit the cement industry requires it to affect a much larger sector of the economy.

Of course, some types of construction such as super-highways and dams utilize more of the construction dollar for cement than do others such as single-family homes. For a given total construction expenditure in the country, the government could slightly alter cement demand by changing the construction mix where possible. This influence is liable to be small, however, in that diverse types of construction tend to be related. Residential construction, for example, produces a lagged but predictable demand for sidewalks, streets, shopping centers, schools, and eventually highways. Highway construction, on the other hand, creates accessibility which leads to factory and residential construction. There appears to be a considerable degree of stability in the construction mix over time, which can be influenced by government action in only a modest degree.

One further area of government influence is that of depletion allowances. Cement producers are allowed to take a depletion deduction on their quarrying operations, in a manner analogous to the oil industry. This has the effect of lowering the effective tax rate for cement companies and improving their after-tax profits. Yet the pretax profits of many cement companies are not now sufficient to permit them to take the full depletion allowance to which they would be entitled. A change in depletion laws would have a highly selective impact, affecting primarily the most profitable producers.

The Tax Reform Act of 1969 eliminated the tax benefits of so-called "production payments". This was a financial device used by the extractive industries as a way to leverage their investment and gain tax deferrals. The benefits have now been disallowed, with some effect in lowering industry profits.

It would appear that the federal government has limited ability to stimulate the cement industry directly, other than by preferential tax or other legislation. Despite this, the government has massive influence over the fortunes of the cement industry, by its ability to influence the overall economy and the construction industry specifically. The government has a sharply focused effect only in such areas as taxes and pollution control legislation.

DISTRIBUTION IMPACT ON MARKETS

Substantial changes in cement distribution have occurred. In some instances the supply area has increased from a local to a regional market. This change is primarily due to the increase in distribution terminals. In the past, plants with access to water transportation have utilized terminals as a way to penetrate distant markets. During the period of substantial excess capacity in the early 1960's, competition increased and prompt customer delivery became an important marketing feature. This forced suppliers to build terminals to gain a service advantage. The mode of transportation changed during the period of 1960 to 1970 in response to the required fast delivery service. The railroad companies have continuously lost business to the trucking industry reflecting a noncompetitive freight structure, as shown in the following table.

SHIPMENTS OF PORTLAND CEMENT FROM U.S. MILLS BY TYPES OF CARRIERS

	<u>1960</u>	<u>1970</u>
Railroad	51%	18%
Truck	47	79
Boat	<u>2</u>	<u>3</u>
Total	100%	100%

Source: Bureau of Mines
(For detailed 1970 breakdown, see Appendix 1.)

As much as 25 percent of total industry shipments involve the use of terminals, resulting in about a 20 cent per barrel increase in transportation costs. This has been absorbed by the cement companies without an offsetting price increase.

Distribution costs are probably changing more rapidly than manufacturing costs. This tends to widen, gradually, the traditional zone of influence. Increased use of water transportation has, and will continue to, make old geographic market definitions obsolete.

The terminals also enable cement manufacturers to pursue selective pricing strategies. A mill with no terminals can publish only one base price, while one which serves a number of terminals may quote a variety of base prices, one at each terminal as well as one at the mill. The base prices quoted at terminals need not be proportional to mill base plus delivered costs to terminals served. In this way terminals can be used as a means of cutting prices in particular areas.*

However, many industry executives feel that the trend toward terminals has stopped. While terminals do widen the distribution area, there is some doubt that their costs can be recovered, or that they improve competitive strength significantly. This feeling may more accurately reflect the need for selectivity in locating terminals than intrinsically bad economics.

We disagree with those who feel that terminals will be less important in the distribution structure. The economics of cement manufacture and distribution indicate that the trends to large plants, terminals, and overwater distribution will continue.

FUTURE DEMAND

It is known throughout the industry that cement consumption is related to new construction expenditures. The nationwide demand for portland cement increased at an annual 2.8 percent compound growth rate during the period 1953-1969. New construction in constant dollars during the same period increased annually by 2.1 percent. This difference in growth rate means more cement was used in new construction as this time elapsed. The ratio of barrels of cement for every \$1,00 of new construction in constant dollars increased from 5.8 to 6.5, growing at an annual rate of 0.7 percent. (See Exhibit 4.8.)

We assume that new pollution control standards for alternative materials like structural steel and asphalt will have effects similar to those in the cement industry; that is, cost and price impacts will be proportionally the same among all these industries. We do not anticipate any changes in the demand cross elasticities and therefore believe that the impact of enforced pollution standards on the demand for cement will be negligible.

* U.S. Federal Trade Commission. Economic Report on Mergers & Vertical Integration in the Cement Industry, 1966, p.66

EXHIBIT 4.8
RELATIONSHIP BETWEEN CEMENT CONSUMPTION AND
NEW CONSTRUCTION EXPENDITURES

New Construction (In 1957-59 \$ Billion)			Consumption*		Barrels per \$1000 of New Construction
		<u>Avg.</u>		<u>Avg.</u>	
1952	42.9		249		5.81
1953	44.7	44.9	259	261	
1954	47.2		274		
1968	64.4		403		
1969	64.2	62.9	419	408	6.49
1970	60.2		403		
Annual Compound Growth Rate (1953-69)			2.1%	2.8%	0.7%

Notes: *Consumption = Shipments + Imports - Exports

** Growth rates based on three-year averages of end points.

Source: U.S. Department of Commerce
(Business and Defense Services Administration)
Bureau of Mines

Total demand for portland cement should grow substantially during this decade, with a general pickup in construction activity and a probable continuation of the trend to more cement use per construction dollar. Rinfret-Boston Associates, Inc., a respected economics consulting firm, estimates that construction will increase in real terms at an annual rate of 4.3 percent in 1971-1975 and 3.3 percent in 1975-1980. The table below translates that estimate into projected cement demand, assuming no growth in cement use per construction dollar and the past 0.7 percent growth.

PROJECTED DEMAND FOR PORTLAND CEMENT

New Construction (1957-59 \$ Billion)		Usage of Cement (Barrels/\$1000 Construction)	Cement Consumption (Million Barrels)
1959	-	5.81	-
1969	62.8	6.49	408
1970	60.2	6.48	390
1971	65.0	-	-
1975	76.9	6.49 - 6.77	499 - 520
1980	90.5	6.49 - 7.01	587 - 634

Source: The Boston Consulting Group and Rinfret-Boston Associates estimates.

Exhibit 4.9 summarizes our estimates of demand and demand growth through 1980. Overall, we estimate the growth rate will rise from the 1953-1969 2.8 percent average to 3.4-4.1 percent through 1980. This will require construction of at least 100 million barrels of productive capacity, in addition to replacing any plants which will be retired. While the growth rates are not high, substantial investment will be required during the next few years unless the U.S. substantially increases imports. It seems likely that total cement plant construction will exceed 100 million barrels of capacity, since plants must be built in reasonable proximity to markets. When the demand in a given market passes the local productive capacity, it will be more profitable to shut down old high-labor-cost plants and replace them with larger automated facilities.

EXHIBIT 4.9
DEMAND FOR PORTLAND CEMENT
(Million Barrels)

	<u>1968-70 Average</u>		<u>1975</u>		<u>1980</u>		<u>Annual Compound Growth Rate (1969-1980)</u>
Domestic Shipments	398	Hi	503	Hi	608	Hi	3.9%
		Lo	482	Lo	561	Lo	3.1
Net Imports	10		17		26		9.0
Total Consumption	408	Hi	520	Hi	634	Hi	4.1
		Lo	499	Lo	587	Lo	3.4

Source: The Boston Consulting Group estimates

This increased demand for cement will not be uniform, either geographically or by end use.

Growth of industrial and commercial construction activities is anticipated to decline, while residential construction is expected to grow rapidly in the future.

Estimates of overall demand tend to obscure important regional variations. Both demographic and new construction projections by the National Association of Home Builders indicate that a number of metropolitan areas in the United States, particularly in the Southern region, will experience above average building activities in the 1970's. (See table below.) Naturally, this will lead to higher rates of cement use in these areas, generally tied to population growth.

METROPOLITAN AREAS WITH EXPECTED ABOVE
AVERAGE BUILDING ACTIVITIES

<u>Midwest</u>	<u>West</u>	<u>South</u>
Cincinnati	Denver	Dallas
Indianapolis	Los Angeles	Houston
Milwaukee	(Orange County)	Louisville
Minneapolis	Phoenix	Miami
Omaha	Portland	Tampa-St.
	San Diego	Petersburg
	San Jose	Tulsa

Cement usage can be related to population as well as to construction growth; all are highly correlated. Cement use per capita (domestic shipment plus imports) in the U.S. rose to a peak of 2.08 barrels/capita in 1969. That is somewhat less than in Europe or Japan, where wood and other construction materials are not as widely available. A demand forecast based on current and projected per capita use and the latest population estimates is shown below. This method of forecasting demand is used by a number of cement companies.

POTENTIAL CEMENT DEMAND, 1980

	<u>Low</u>	<u>High</u>
U.S. Population Projections (millions*)	227.7	236.7
<u>Barrels/Capita</u>	<u>Millions of Barrels</u>	
2.03 (current level)	462	480
2.16 (middle range)	491	511
2.28 (continuation of growth trend)	519	539

* U.S. Bureau of Census Series B and E, November, 1971

These estimates are somewhat lower than our earlier domestic consumption estimates of 587-634 million barrels, which several industry executives feel are on the high side. Those forecasts assume a rate of construction put in place during the 1970's which is sharply higher than that of the past ten years. In short, an increased rate of construction put in place implies that the historic rate of cement use per capita will accelerate. Most industry sources feel that the historic rate of per capita use will be continued, but not increased, and typical industry projections of demand growth are below ours.

Section 5

FINANCIAL RESOURCES OF THE CEMENT INDUSTRY

Pollution control is at its root an economic issue. Our interviews indicate that the cement industry does favor an increased level of emission and water quality control, consistent with the national trend toward an improved environment. Its willingness to invest is naturally conditioned by the total cost of controls, the ability to recover those costs in an appropriate manner, the ability of individual companies to provide the capital needed to reach satisfactory levels of control, and its perception of the attractiveness of alternative investment in other industries.

The issues involved reduce basically to three.

1. What will be the costs of pollution control, in terms of capital outlays and operating costs, and how these costs will be reflected in the finished product price. There is good evidence that these costs will vary widely among plants, with older, smaller plants having proportionally higher costs than larger and newer plants.
2. What will be the impact of these cost increases? If these costs cannot be recovered by price increases, then the already low returns of the industry will drop further, and dividends or the ability to grow will be reduced. If the costs can be recovered by price increases (as seems likely), then there may be an impact from use of substitute materials and/or increased imports.
3. Whether the industry can provide capital from existing profit levels, projected price improvements, and depreciation charges: or whether there must be a change in dividend and

debt policy. If all these sources are insufficient, then alternative sources of capital must be found, implying the entry of outside capital into the cement industry with corresponding impacts on the competitive strength of existing firms.

The answers to all these issues can be estimated from a review of basic economics of the cement business. This section of the report is directed to a summary of typical operating cost structures, capital costs and investment practices, the characteristic financial structure and policies of representative companies, and the relationship of pollution control costs to financial resources.

PLANT ECONOMICS

The cement industry today consists of essentially four types of plants. Multiplant companies own varying numbers of the individual types. Although this categorization does somewhat oversimplify the differences among plants, it permits a generally valid comparison of plant economics and an understanding of the reasons for cost, profit, and investment differences between plants and among firms in the industry.

As can be seen from Section 2, there are significant differences in the age, size, and capital and operating costs of plants in the U.S. cement industry today. Since freight costs are high relative to product value, the prevailing market pattern in the industry has been regional. Within this framework the following four plant types are most common:

	<u>Age/Size of Plant</u>	<u>Type of Market</u>	
		<u>Major Metropolitan Market</u>	<u>Isolated Market</u>
I	Old, small plant	X	X
II	New, small plant		X
III	New, large plant	X	

Large new plants (Type III) have been built in the 1960's in or near major metropolitan markets such as California, the upper Midwest, and the New York/Pennsylvania area. They have exceeded five million barrels of capacity. These plants have far more favorable costs.

At the same time, smaller, relatively modern plants (Type II) have been built to serve more isolated markets such as those in many states in the Mountain and West South Central regions.

Although there has been a tendency for many of these plants to close, there are still a significant number of older (pre-1960) plants of small to medium size (up to two million barrels) which serve major metropolitan markets. These Type I plants have felt the brunt of competition from the newer, larger Type III plants.

A plant's profitability will, in general, tend to be a function of:

- its share of a regional market
- its age, and
- its size.

In general, new plants are lower-cost producers than old plants of comparable size; large plants have lower costs than small plants of similar age. But while this is generally valid, we have been shown some distinctive exceptions: old, small plants with very low costs, and large relatively new plants with poor cost performance. The cost advantages of newer and larger plants are not automatic, but depend on attractive and careful management to realize the potential advantages.

Exhibit 5.1 indicates representative manufacturing costs for the three types of plants. These data, originally published in Rock Products, have been checked with various firms in the industry and are felt to be generally representative of the inherent cost advantages of newer and larger plants. Naturally individual plant comparisons can vary if plants with differing ages, manufacturing processes (wet or dry) or quarries are compared.

Plant A, the old two million barrel plant, is at a competitive disadvantage compared with the two newer plants. The competitive advantage of the newer plant becomes more apparent when comparing the cash costs per barrel.

EXHIBIT 5.1

TYPICAL CEMENT MANUFACTURING COST

	Plant A Typical Old 2 Million Bbl. Plant	Plant B Typical Modern 2 Million Bbl. Plant	Plant C Typical Modern 4 Million Bbl. Plant
Labor	.99	.39	.27
Fuel	.40	.28	.24
Power	.21	.21	.21
Miscellaneous Supplies	.20	.20	.20
Maintenance Materials	.20	.12	.12
Overhead	.21	.10	.10
Depreciation	.50	.35	.25
Cost/Barrel	<u>\$2.71</u>	<u>\$1.65</u>	<u>\$1.39</u>

Additional cost allowances must be made to provide for raw materials (quarry, gypsum), terminals, and freight.

Source: Rock Products, April, 1968.

Plant A	\$2.21
Plant B	1.30
Plant C	1.14

The out-of-pocket costs for Plant A are almost twice as high as for Plant C.

The cost advantage of newer and larger plants is somewhat reduced when only variable cash costs are considered. Insofar as any future cash expenditure is discretionary, it is a variable cost. But in a cement plant we speak of variable costs as those which change with a change in operating rate, so long as the plant operates at all. For practical purposes, these are only fuel and power costs. The rest are relatively fixed if the company is to remain in business. The comparison of variable costs per barrel is as follows:

Plant A	\$.61
Plant B	.49
Plant C	.45

Still the newer and larger plants have an advantage. There is rarely an advantage without a penalty, though it appears that this is the situation of Plant B. It, the modern two-million barrel plant, is as low as or lower than its older counterpart in every element of cost. For this reason, Plant B will also break even at a lower operating rate than Plant A.

Plant C has costs as low as or lower than Plant B. It has a lower breakdown point as a percentage of rated capacity. The total fixed costs involved are higher, and the company must sell about twice as much cement to break even. More capital is at risk as well.

So while there is a distinct profit advantage to new plants over old, the decision to build a large or small plant is less clear. It depends mostly on the size of the market and the company's expectations for market share. It depends as well on the company's ability to raise the extra capital needed for a larger plant and its willingness to invest the extra capital in a single venture. And it depends on a quarry large enough to provide the needed volume of quality raw material. Given these conditions, it appears that the larger the plant, the higher is the potential profit.

EXHIBIT 5.2

REALIZED PRICES AND COSTS
OF TWO TYPICAL CEMENT PLANTS

Plant 1

Capacity: 3-5 million barrels range

Capacity Utilization: about 75%

Approximate Age: less than 10 years

	<u>1971</u>	<u>1970</u>	<u>1969</u>
Cost/barrel	2.17	2.07	2.24
Price/barrel	3.50	3.30	3.20

Plant 2

Capacity: 1-2 million barrels range

Capacity Utilization: 95%

Approximate Age: over 40 years

	<u>1971</u>	<u>1970</u>	<u>1969</u>
Cost/barrel	3.63	3.34	2.92
Price/barrel	3.80	3.40	3.40

Descriptive ranges given to conceal
identity of plants.

Source: The Boston Consulting Group interviews.

Exhibit 5.2 provides further comparisons using data obtained from a multiplant firm's internal cost and realized price data. Plant 1, the newer plant, produces cement at a significantly lower cost than Plant 2, its much older counterpart. The specific cost figures differ from those presented in the first cost comparison, but the cost advantages of the newer plants are apparent in both examples.

Plant 2 has operated at slightly above breakeven despite the fact that it has achieved a 95 percent operating rate. This means that it is just about covering its full accounting costs, but making no significant contribution to corporate overhead, interest, or other general costs. Despite this fact, the company continues to operate Plant 2 because, even with its low profit and unsatisfactory return on investment it is still providing a positive net cash contribution. Its depreciation charges (approximately 25¢/barrel) are not being reinvested in this plant and, for the time being, against the alternative of shutdown at little or no scrap value, the company is better off continuing to operate. Of course, no new capacity with these cost characteristics will be built. Additionally, Plant 2 (Exhibit 5.2) and Plant A (Exhibit 5.1) suffer their greatest disadvantage in fuel and labor costs which have both been rising sharply. The unfavorable cost trend of Plant 2 from 1969 to 1971 is largely the result of the effect of these rising costs.

One of the key differences between new and old, large and small plants is in their utilization of labor. Modern plants are heavily automated. Large plants require only a few more employees (mostly for maintenance) than small plants. As the industry has expanded and modernized its plants, labor needs have dropped steadily. One example is that a large cement company is studying now whether to double the capacity of one of their older plants by rebuilding it entirely. The rebuilt plant, with twice the output, would require 30 percent fewer people, or a labor savings per barrel of 65 percent.

Exhibit 5.3 shows the trend in labor hours per thousand barrels of cement for selected years 1940-1970. The data cover 132 plants in 1970, about 75 percent of industry capacity. Clearly, efficiency of labor utilization has improved steadily over this period. (Note that 1968-1970 figures include labor for packing, about 16 man-hours/thousand barrels, not included in earlier figures.) The dramatic difference in labor needs for small and large plants is evident as well in this display.

EXHIBIT 5.3

GRAND AVERAGE MAN-HOURS PER 1000 BBL. EQUIVALENT PRODUCTION

Year	Over 2,000,000 Bbl.		Over 1,000,000 Bbl.		Under 1,000,000 Bbl.		All Plants		Percent Capacity Utilized	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet		
1970	131	131	143	147	199	198	151	153	153	79
1969	134	124	146	146	190	199	150	151	151	80
1968	137	133	150	149	194	184	155	154	154	80
1967	138	126	144	132	175	163	145	134	138	78
1966	142	127	147	136	231	203	150	138	143	84
1965	149	130	158	144	209	221	160	147	152	83
1964	157	138	165	148	252	211	168	152	159	79
1963	165	143	172	154	297	234	177	159	167	77
1962	167	153	180	163	297	231	185	168	175	77
1961	181	157	199	169	286	245	203	175	186	76
1960*	-	-	-	-	-	-	216	191	202	77
1955*	-	-	-	-	-	-	259	215	235	92
1950*	-	-	-	-	-	-	305	257	278	86
1945*	-	-	-	-	-	-	386	347	364	50
1940*	-	-	-	-	-	-	363	321	340	56

Grand total man-hours for these years includes shutdown hours, but no packing, shipping, or sacking.

Includes Packing

Grand total man-hours for these years includes shutdown hours, but no packing, shipping, or sacking.

Note: *Average figures not readily available.

Source: Portland Cement Association

Exhibit 5.4 shows approximate man-hours/barrel for one major company for the current year through September, again showing the powerful differences caused by age and site of plant.

The value of labor savings depends on the price of labor. For one multiplant company, fully absorbed labor costs average \$7.15 per hour (average \$3.80 hourly rate). That company computes that by doubling the size of its typical plant, it would increase total labor force by only 40 percent. Assuming a two million barrel plant requiring 125 man-hours/thousand barrels now, it would move to a four million barrel plant requiring only 100 man-hours/thousand barrels. Labor savings would be 25% x \$7.15 per thousand barrels, or 17.9¢/barrel. Alternatively, the incremental labor cost for the incremental output would be only 36¢/barrel, versus the current labor cost of 89.5¢/barrel. Increased interest charges and shipping charges would consume most of those savings, since the larger plant would require a wider distribution area.

But labor is not the only saving in a modernized plant. Fuel consumption can be improved. In one particularly extreme example, an officer of a large producer reported that fuel consumption in two of its oldest, smallest plants was 1.3 million BTU/barrel and 3.3 million BTU/barrel. By contrast, a modern plant requires only 0.9-1.0 million BTU/barrel.

Labor, fuel, and power savings provide a powerful impetus to plant modernization and expansion. The cash flow from increased depreciation and depletion allowances further enhance the appeal. Offsetting these are the inevitable price erosion in the battle for increased share of market for the larger plant, and the decline in average mill net price as distribution area is enlarged. A stylized pattern of these relationships is shown in Exhibit 5.5. Clearly, there is a point beyond which further expansion is unprofitable. Nevertheless, the company with a long investment time horizon, which invests in a very large plant even at the expense of near term profits can effectively freeze out its regional competitors from expanding, and is therefore in the best position to gain market share as the local market grows. Its profits will improve over time, as competitors' profits erode.

EXHIBIT 5.4

1971 MAN-HOURS/THOUSAND BARRELS
FOR A MAJOR CEMENT COMPANY

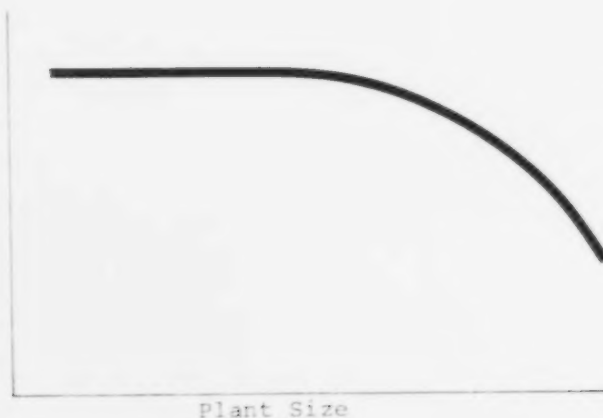
<u>Plant</u>	<u>Capacity Range (Million Bbl.)</u>	<u>Man-hours/ Thousand Barrels* (1971 through Sept.)</u>	<u>Approximate Age of Plant (years)</u>
A	1-2	225	40+
B	2-3	46	0-10
C	2-3	91	20-30
D	3-4	61	10-20
E	3-4	83	0-10
Company Total		104	

Note: *Figures partially disguised to protect company
identity; not all plants shown.

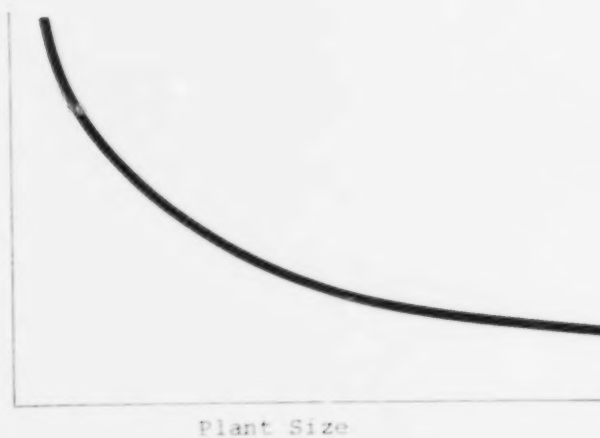
EXHIBIT 5.5

TYPICAL COST AND PRICE RELATIONSHIPS
IN PLANT EXPANSION ANALYSIS

Average
Mill Net
Price



Average
Cost/Barrel



CAPITAL COSTS AND INVESTMENT PRACTICES

The cement industry currently estimates capital costs at \$10 per annual barrel of new capacity. This figure is a rough average. It decreases with size of plant. It increases with inflation in construction costs and with increased equipment (such as automation and pollution control devices).

The \$10 rule-of-thumb seems to be on the high side when compared with reported costs of new plants over the past decade or so. Exhibit 5.6 shows the capacity and total costs of 20 new plants and major expansions in 1960-1969. The average cost per barrel is just under \$7.00. In fairness, these costs may have been understated for public consumption, but it seems doubtful the true cost was as high as \$10.00 per barrel.

There appears to be some tendency for an increase in the cost of new capacity. The average cost of plants built during 1961-1965 (Exhibit 5.6) about equals the average cost of plants built during 1966-1969, both are just under \$7.00 per barrel. Yet the average plant size increased from 2.55 million barrels to 3.41 million barrels. The economies of scale of increased plant size were, on average, wiped out by the inflation in construction costs. As noted elsewhere in this report, we can expect a consistent increase in average plant size over the next ten years. It is not unreasonable to use the historical \$7.00 per barrel figure as a rule-of-thumb for new plants, possibly increased to \$7.50 if construction costs continue their steep climb and the growth rate of average new plant size slows a bit.

Prior to the last ten years, construction costs did not escalate so rapidly. There was a drop in capacity costs up to the early 1960's, which may have contributed in part to the heavy building of new cement plants in the late 1950's. Exhibit 5.7 shows capacity costs for five plants built prior to 1960. Although these five may not be representative of plant costs earlier in this century, it is interesting to see that those costs averaged \$10.75 per barrel for plant sizes averaging 2.3 million barrels. It may be that such a historic average figure is the source of the often used rule-of-thumb of \$10.00 per barrel. (This drop in capital costs is reflected in the depreciation allowances in Exhibit 5.1.)

EXHIBIT 5.6
HISTORICAL CEMENT PLANT CONSTRUCTION COSTS

<u>Year</u>	<u>Capacity</u>	<u>Cost (mm)</u>	<u>Cost/bbl</u>
1960	1.25	8	\$ 6.40
1960	1.8	18	10.00
1961	1.7	12.5	7.35
1961	2.7	17	6.30
1962	8.5	42	4.94
1962	1.5	15	10.00
1963	1.4	10	7.14
1964	1.5	12	8.00
1964	1.75	18	10.29
1964	1.0	15	15.00
1965	3.0	25	8.33
1965	4.5	21	4.67
1966	3.3	20	6.06
1966	2.0	10	5.00
1967	7.0	60	8.57
1967	2.5	20	8.00
1967	4.0	25	6.25
1967	3.0	17	5.67
1968	2.5	20	8.00
1969	4.0	20	5.00

Source: Rock Products, May 1968
and Industry Interviews

EXHIBIT 5.7

HISTORICAL CEMENT PLANT CONSTRUCTION COSTS

<u>Year</u>	<u>Capacity</u>	<u>Cost (mm)</u>	<u>Cost/bbl</u>
1906	2.60	\$32.0	\$12.31
1911	3.30	28.5	8.64
1911	1.10	7.7	7.00
1940	2.00	25.5	12.75
1958	2.65	31.1	11.74

The decline in capital costs is all the more impressive in the face of inflation. If adjusted to constant dollars, new plant capital costs would show a steady decline. This phenomenon of declining costs (in constant money) with increased experience or accumulated production has been observed in many industries. The Boston Consulting Group calls it the experience curve. Insufficient data are available to plot an exact slope of plant cost reductions, but the available figures strongly suggest it has occurred. We can expect continued reductions in capital costs (in constant dollars), in part as a function of increased plant size.

The real issue of capital costs is how effectively those capital expenditures produce revenues and profits. This is particularly critical in evaluating the choice between maintaining and improving an existing plant versus replacing it with newer, more efficient, and perhaps larger plant.

With cement prices in the range of \$4.00 per barrel, this historic \$7.00 average capital cost indicates a sales-to-investment (or capital turnover) ratio of .55-.60. This shows that cement is one of the most capital intensive of all industries.

This large capital outlay and low turnover ratio are major deterrents to investment in cement facilities. A new five million barrel plant may cost \$35 million and produce \$20-22 million in revenues, assuming the market will absorb the additional cement at current prices, or competition will shut down approximately corresponding capacity. In short, new capacity is costly and must have a lengthy economic life if it is to be attractive.

A company already in the cement industry will look at the incremental investment, net of possible scrap value of the existing plant, against projected operating cost savings. A new plant of comparable size may give operating cost savings of \$1.00 per barrel on a full-cost basis. With capital costs of \$7.00 per barrel, an incremental rate of return approaching 15 percent seems to be available. Despite this, virtually none of the large (over five million barrel) plants have been built by companies which were among the ten largest firms in the industry in the 1950's. In fact, a large fraction of the industry's total net new capacity from 1960 onward was built by companies either new to the industry or previously among the small firms.

Since the cement industry is known for the widespread availability of technical information, these major differences in investment behavior must be explained by other factors, such as differences in perception, risk aversion, financial policy, or availability of financial resources. It would certainly appear that replacing old plants with new would be attractive to existing producers.

The fundamental reason that we find much of the new investment, and most of the leadership in plant size, among new entrants or previously small firms is the magnitude of changes required in financial policy and structure for existing large firms. A cement plant, once in place, can produce substantial cash flow. Most of this can be paid as dividends. As the plant becomes increasingly depreciated, reported return on investment can become very high. When the plant is fully depreciated, it can continue operating for many years, and the net shareholder investment is only the working capital. While profits may be low relative to potential profits of a new plant, they can be high relative to the small capital invested. Incremental return on investment in a new plant may be as high as 15 percent, but to provide that investment the company must cut its dividend or raise a great deal of debt, or both.

New plant investment can mean a shift to more highly leveraged capital structure. Interest charges eat up some of the improved margins. If the debt is to be repaid, some of the operating earnings must be diverted from dividends to do so. If the projected new plant is to be larger than the existing plant, as is often the case, then additional marketing and distribution efforts will be needed. They are costly and have some risk. With increased capacity, near-term prices can be expected to soften. Altogether, these factors amount to a radical change in business as usual for the company, and quite possibly lead to considerable apprehension by shareholders. The senior managements of many formerly leading cement companies may simply have determined that it was more in the shareholders' interest to maintain and operate the existing investment, paying high dividends, than to embark on a prospectively more perilous course of increased commitment and deferred reward.

The opportunity would appear much differently to small companies or outsiders. They would normally focus more on investment rewards than on the change from past practice and stockholder reaction (which could even be favorable, due to the implications of growth and diversification). It is perhaps not surprising then that perceptions among investors have differed, with resulting major changes in market position except for a few companies.

PLANT EXPANSION AND NEW CONSTRUCTION

Over the next ten years the U.S. cement industry will be called upon to build a large amount of new capacity. The total amount to be constructed depends, of course, on the magnitude of future demand growth. Our estimate of the net new capacity needed ranges from 148 to 203 million barrels over the next decade. The gross amount of new construction will be greater, depending on how much existing plant is retired during the period. Projected closings, gross capacity needs, the costs required to construct the capacity, and financial capability, are discussed below.

The location of this new capacity is likely to be significantly different from that built during the peak years 1955-1965. During the 1970's most new capacity will be located on sites where a cement plant already exists rather than on entirely new sites. This was not the case during the past 15 years. Between 1960 and 1971 25 new sites were developed for cement plants. These plants represent a majority of the new capacity constructed during that period. New plant sites were developed in both isolated markets and in larger markets where there was substantial competition.

The isolated markets (Nevada, North Carolina and the like) were previously served by cement imported from other states. As the population of these markets expanded and the demand for cement grew, it became feasible to construct a local plant to serve local needs. In states where there were already plants, new plants were constructed both to cut down on transportation costs from plants in different parts of the state and to obtain the benefits of scale.

At the present time, however, there are cement plants in 40 different states. Five of the states without plants are in New England where high fuel costs act as a substantial barrier to the economical operation of a cement plant. There are few, if any, market areas left large enough to support their own plants and with suitable raw material and fuel resources that are long distances from a currently operating plant.

There are strong economic and other factors suggesting the use of existing sites for plant expansion. If a new plant is built on an old site, the cement customers developed for the old plant serve as a base demand for the new facility. This demand can be met without disrupting competitive patterns in the market. If an entirely new facility is constructed

in a previously unserved market, however, the situation is very different. Because total cement demand is highly inelastic, especially in the short run, all the sales from the new plant must be taken from other competitors. The most common competitor tactic is price cutting. This is highly disruptive of competitive patterns and tends to result in lower prices and returns for all the companies involved. This is beneficial to customers, at least in the short term, but unpopular with manufacturers. The construction of just a few large new plants in already crowded market areas is considered by many in the industry to be one of the prime causes of the severe price declines in the early 1960's.

As the number of new geographically protected markets declines, there are other reasons which will tend to place new capacity in existing sites. In the current social and political climate there is much concern about the introduction of large industrial complexes in previously nonindustrialized areas. Substantial local opposition is likely to develop to a new cement plant, despite assurances of high-level pollution control. Zoning may be difficult or impossible to obtain, either for kiln or quarry operations.

In a previously agricultural or wooded area a new plant may involve a substantial change in the pattern of land use. These changes give rise to local opposition from citizen's groups and conservationist organizations. In the vicinity of an existing site, on the other hand, land use patterns will have developed around the cement plant. Replacement of one facility with another, particularly if the new facility will have significantly less particulate emissions, is likely to have little deleterious impact on the local population and habitat. Most of the changes are likely to be beneficial. Much less local opposition will be encountered at an existing site than at a wholly new location.

In addition, a cement plant requires a large property, a minimum of several hundred acres situated on a suitable limestone deposit. According to industry sources the number of untapped deposits of high-grade limestone located near major market areas is declining. At existing sites, however, the remaining quarry reserves may be extensive even though the plant currently on the site is obsolete. It is far cheaper to expand quarry operations in an existing quarry than to start a new quarry.

Finally, there are real savings to be realized by

utilizing an existing site for a new plant. Even though the old kiln and grinding machinery must be removed, there are parts of the old facility, often involving substantial replacement values, which can be used. As previously noted, only larger machinery is needed to modernize the quarry. All the costs of opening a new quarry are eliminated. The plant roads, storage silos and office space may also be utilized. There is already a pool of trained workers familiar with cement plant operation. Trucking arrangements, agreements with local suppliers and marketing operations are already in existence.

All these factors--local opposition, zoning problems, limestone resources, and utilization of parts of an old facility--strongly indicate a trend in the years to come toward additions to existing plants and replacement of these plants on the same site rather than development of entirely new plant locations.

LARGE PLANTS AND LARGE KILNS

The gap between the supply and demand for cement is rapidly closing after over a decade of excess capacity, and shortages are likely to develop as early as the spring of 1972. The lead time involved in construction of new capacity is from two to four years. Since there is little new capacity now under construction, it can be expected that a short supply situation will persist for at least two years. If this is the case and prices rise in response to a favorable supply-demand balance, the high operating leverage of the old cement plants may convert a breakeven or loss operation into one which returns respectable profits, albeit temporarily. The cash flow picture is especially attractive if, in the expectation of an imminent shutdown, little or no funds are expended for plant upkeep.

The time allowed in the pollution regulations for the implementation of the standards serves this strategy well. Faced with the need for a substantial expenditure on pollution control, the owner of a small old uneconomic plant may prefer an "end-game" strategy. If enforcement of the standards can be delayed at the plant in question for two to three years while the supply shortage lasts, the temporarily higher prices will provide a great advantage. When operating variances, requests for extension

and other delays are exhausted and a firm deadline for control arrives in 1974 or 1975, it is likely that substantial new capacity will also be coming on stream, in the form of very large plants and large kilns. This capacity is likely to result in lower prices. The combination of lower prices and the need for making the pollution control investment will result in the closing of many old plants at that time. If the sequence of events described does occur, it is likely that a significant number of small old plants will remain open until the control expenditures actually become necessary or prices decline under the pressure of significant new capacity additions. These events are likely to occur simultaneously between 1973 and 1975. Pollution legislation may be blamed for the closing of plants which were noncompetitive for economic reasons. But some of these plants may have been kept open merely to take advantage of expected higher prices in the 1972-1974 period. Plants of under three million barrels capacity which were built before 1960 represent 183 million barrels of capacity or about 36 percent of the industry total. Many of these are in market areas where that is the appropriate size of plant, but it is probably not excessive to estimate that 10 percent of the industry capacity is in plants clearly under size for their market area.

As we have seen, there is a steady trend in the construction of very large plants, say over six million barrels. As the size of a plant increases, there are economies which reduce the installed cost per barrel. There are economies of scale in the plant itself. Some facilities like roads, offices and the quarry are relatively insensitive to size and their cost may be spread over more barrels in larger plants.

On the other hand, there are also risks in building larger and larger facilities. Having a large amount of production concentrated in one facility increases the vulnerability of the operation to market fluctuations, strikes, or natural disaster. Having a plant's capacity in just one kiln exacerbates the concentration problem. Kiln "downtime" becomes very serious with regard to maintaining the supply of cement to customers. Technical difficulties or relining can create the need for costly shipments from other areas in order to maintain inventories and keep customers satisfied. Exhibit 5.8 shows the average kiln size of the largest U.S. cement plants graphed against their year of construction or kiln construction. The exhibit covers 17 of the 20 largest plants, omitting National Gypsum, Alpena, Michigan (16 million bbl.); Southwestern Portland, Victorville, California (7 million bbl.); and General

Portland, Colton, California, for which detailed data were not available. The largest plant of all, National Gypsum Company's Alpena, Michigan plant, has 16 million barrels of capacity but consists of 19 kilns built over the past 60 years, an average of less than one million barrels per kiln. This is typical of most older plants, which were usually groups of small kilns rather than one or two very large kilns.

As can be seen from Exhibit 5.8, virtually no kilns larger than two million barrels were built before 1959. Large plants consisted of many small kilns built side by side. While economies in quarrying and grinding may have existed, there was little or no advantage in kiln size over a one-kiln, one million barrel plant. Since that time there have been at least eight kilns built with capacity between two and three million barrels. At least four kilns have been built with capacities over four million barrels: two of 4.25 million barrels each at Atlantic's Ravena, New York plant; one of four million barrels at Medusa's Charlevoix, Michigan plant; and one of seven million barrels at Dundee's Clarksville, Missouri plant. There is a distinct trend to a larger average kiln size, even in this abbreviated display.

The trend toward increased kiln size and greater plant size will continue. Large kilns do create engineering and operating problems, but these will be overcome through increased experience and possibly by importing European and Japanese technology. It seems clear that the optimum kiln size is now above three million barrels, in areas where market size will support such volumes. The trend toward giant plants of six million barrels and above will very probably be met by two-kiln and three-kiln plants, rather than supersize kilns. Industry spokesmen have lost confidence in the very largest kilns, partly due to low flexibility and high risk, and partly due to bad experiences of, in particular, Atlantic Cement and Dundee.

Atlantic's problems with its machinery have been documented in its parent firms' annual reports. Industry sources indicate that Dundee's kiln, very likely the largest piece of rotating machinery in the United States, has also experienced technical difficulties. With these experiences in mind, it is likely that future kiln size will tend to cluster in the three to four million barrel range rather than the larger sizes of four million barrels up. Similarly, grinding facilities will generally consist of several smaller ball mills rather than a single giant.

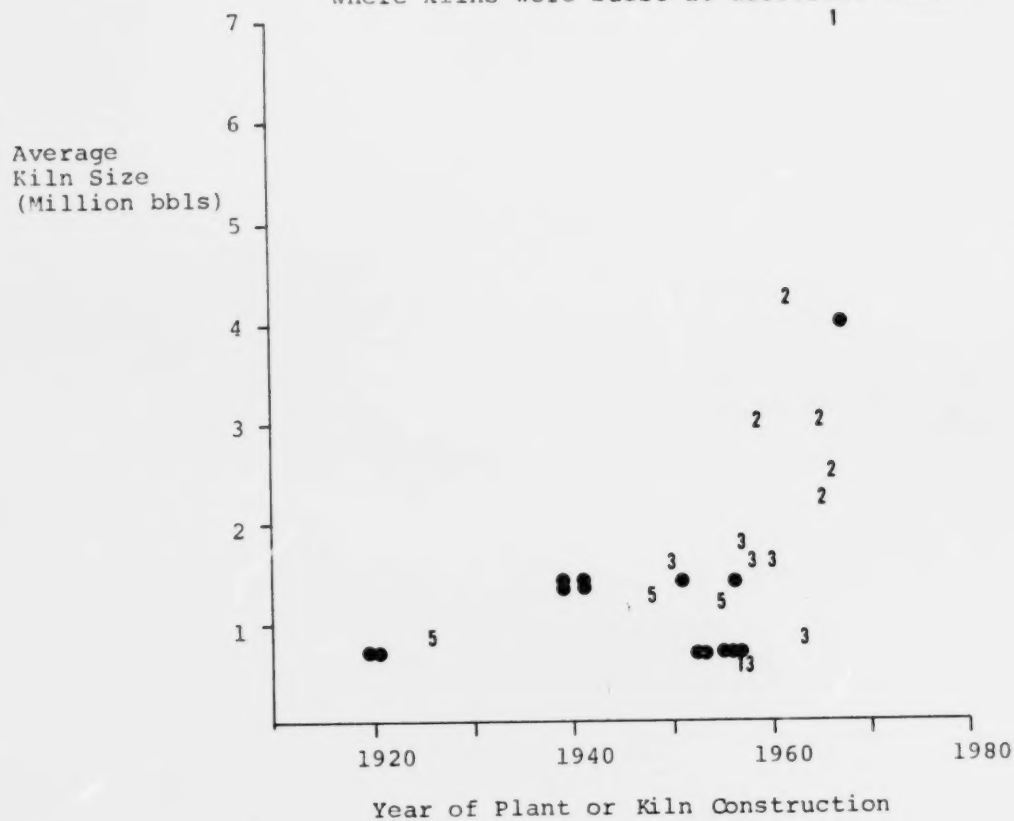
EXHIBIT 5.8

AVERAGE KILN SIZE Vs. AGE OF KILN
17 OF 20 LARGEST U.S. PRODUCERS

Legend

2 Indicates number of kilns in a plant
where all kilns were built at one time

• Indicates individual kiln at a large plant
where kilns were built at different times



Source: Rock Products, May 1968
Cement Company Interviews

European and Japanese cement plants are often much larger than U.S. cement plants. We do not have a detailed tabulation of foreign plants by site, but a few illustrations show the types of plants found in Europe and elsewhere outside the United States. (See following table.) The Japanese are also reputed to have a number of very large kilns and giant plants. There seems to be some indication that cement producers offshore may have some technological expertise in the operation of giant kilns not available domestically.

The Japanese cement industry appears to be one of the most concentrated in the world. The average Japanese plant in 1968 produced over twice the output (4.4 million barrels) of the average U.S. plant that year (2.1 million barrels). The Japanese are also the world's leading exporter of cement, although less than one percent of their output reaches the United States. Interestingly, the Russians have by far the world's largest cement industry (515 million barrels in 1968), and the fastest growing. (Production grew 12.5 percent annually 1948-68.) This probably implies the existence of very large plants in the Soviet Union also.

<u>Owner</u>	<u>Location</u>	<u>No. Kilns</u>	<u>Rated Capacity</u>
ENCI Cement	Maastricht, Neth.	1	15,500 bbl/day =5.5 mm bbl/year
Dykerhoff	Weisbaden, Germ.	2	27,600 bbl/day =9.7 mm bbl/year
Holderbank* Group	Clarkson, Ont., Canada	3	9 million bbl/year
Holderbank Group	Brussels, Belg.	9	14.6 mm bbl/year
N.A.	Japan	1	7.7 mm bbl/year

Note: *The Holderbank Group also owns the biggest single cement kiln in the world, the 6.9 million barrel kiln at the Dundee Cement plant in Clarksville, Missouri.

FINANCIAL STRUCTURE AND POLICY

Financial behavior varies among cement companies quite widely. It is our belief that study of past financial performance and policy gives great insight into probable future events, even including identifying companies whose profits are likely to improve and those who will, over time, close plants and withdraw from business. We will review the financial characteristics of eight companies. These eight represent about one-third of the industry's capacity, operate the four major types of plants outlined previously, and cover perhaps the full range of financial behavior seen in the industry.

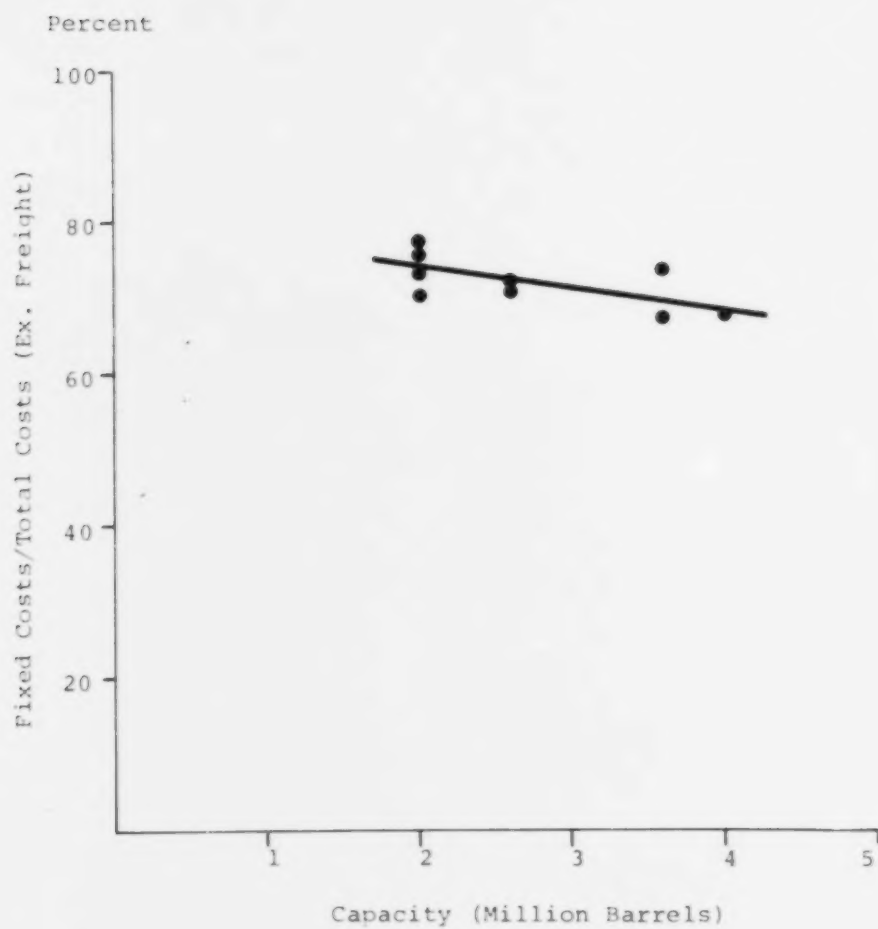
Interestingly, no company in the industry uses a high level of debt. Many companies may keep their debt low due to high operating leverage. Exhibit 5.9 shows the ratio of fixed costs to total costs at full capacity for several actual plants on which we have operating statistics, plus the three typical plants described in Exhibit 5.1. For all these plants, fixed costs are from about 70-75 percent of total costs, indicating a high breakeven point at normal prices. Variable costs are correspondingly low, so profit rate is high after the breakeven point is passed. Fixed costs are a higher percentage for smaller plants, because of their higher labor content, so the operating structure of small plants is even more leveraged. With such operating leverage, it is not surprising that most cement companies prefer only modest financial leverage. The penalties for running below breakeven would be simply too severe. However, some new entrants have adopted a high-debt policy, anticipating high operating rates for large plants.

The main impact of financial policy is in its effect on the company's ability to finance growth. Over time, no firm can grow faster than its equity growth. In the short term, growth is affected by changes in turnover ratio, debt ratio and margins. It can be shown, though, that margins and return over time for any company tend to be stable unless there is a pronounced change in market position. Turnover and debt ratios can not improve indefinitely, and so it is the ability to maintain equity growth that is a company's limiting financial resource, and therefore the limit on its growth rate in sales, assets, and dividends.

We call this the sustainable growth rate. It is primarily a function of the company's earnings retention, return on assets, and debt/equity ratio. A high retention of earnings, high return on assets, and high debt/equity ratio all contribute to high sustainable growth.

EXHIBIT 5.9

FIXED/VARIABLE COSTS VS. PLANT CAPACITY



Some simple graphical displays are useful to demonstrate the differences in financial policy among cement companies, and how those policies affect their ability to finance growth. We will use the actual reported statistics of our eight sample companies to illustrate the financial resources and policies of the cement industry, somewhat modified to disguise actual identities. Let us name the companies after eight of the planets.

Our displays show four major financial characteristics. First is the company's sustainable growth rate over time; that is, the rate at which the company is expanding its equity. We label that line G_S . A dotted line overlaid on the same graph shows the actual growth rate, labeled G_A . Although actual growth fluctuates more widely than sustainable growth, on trend they must be, and are, virtually the same. The only exceptions occur when the company makes a substantial and continuing change in financial policy or operating performance.

The major control over sustainable growth is the earning power of the company and the amount of earnings retained. We show the elements of sustainable growth in three separate displays, the earnings retention policy, the return on assets, and the debt-to-equity ratio. A high debt ratio provides leverage to the return on assets, and so allows the shareholder's equity to grow faster. If the return on assets is below the interest rate then the leverage has a negative impact, and growth rate will be slowed. The use of debt then has the effect of amplifying differences in performance, so that successful companies who use debt have accelerated growth and gains in market share while poor earners who use debt find their growth restricted and usually lose market share. This effect occurs both with the financial leverage power of debt and the operating leverage power of a high fixed cost ratio.

Mercury Portland Cement Company is a good example of a firm with stable financial characteristics. As shown in Exhibit 5.10 Mercury has held its sustainable growth rate to an average of about 1% per year for the past ten years. The company's actual growth has fluctuated more widely, but has averaged somewhat less than the potentially sustainable rate, about -1%. Since the industry overall has averaged about 2.5% growth, Mercury has on balance lost market position. Normally this is consistent with a decline in earning power, and, as expected, Mercury has shown a slow and steady erosion in return on assets. The company has kept a steady policy of using about 35% debt-to-equity in its capital struc-

ture. With the 4% or so return on assets early in the decade, that should have allowed Mercury to grow at 5-6% annually, gaining market share and improving earning power. The basis for this difference is in Mercury's policy for earnings retention. The company paid out over 90% of its total earnings during that period as dividends, restricting its ability to finance growth to a level below the industry average. Without a change in financial policy, it is likely that Mercury's earning power will continue to erode, since the company continues to lose market share. Pollution control requirements which lead to plant closings will only hasten what appears to be Mercury's slow and steady liquidation of its position.

Venus Portland Cement Company (Exhibit 5.11) shows a sharp contrast to Mercury. Venus has shown a steady decline in sustainable growth rate, for the past five years, but except in 1970 has always been able to grow faster than the industry average. Venus's actual growth equaled sustainable growth until 1965, when there is evidence of a substantial change in financial policy. The slowly eroding debt ratio was reversed by a policy which allowed debt ratio to rise to 0.6:1. The high marginal debt ratio in 1966, 1967, and 1968 funded very high growth for several years. Venus reversed its decline in market share, rising steadily in position during the past several years. Return on assets has dropped, in part reflecting the rapid building of assets and possibly reflecting price competition as an instrument to gain market position. Although Venus's policies have worked well, their effect has been somewhat attenuated by the company's increased payout of earnings, or declining retention ratio. With declining ROA and increasing debt, a less liberal dividend policy would be appropriate if the company's goal is continued growth. Nevertheless, it is unlikely that Venus will close plants because of competitive pressure; it is investing to cause competitors' plants to close. Since Venus has put extensive pollution controls on its new plants, it would be unlikely that this firm would be appreciably hurt by pollution legislation unless it is so severe as to cause scrapping the existing systems.

The Good Earth Portland Cement Company (Exhibit 5.12) shows an even more dramatic impact of changing financial policies. Sustainable growth and actual growth were both low until 1967, when earnings retained went sharply up. Growth rate and return on assets both reversed their down trend, again approximately stabilizing when retention reached a new level of 40 percent. The company seems now to be pursuing an additional change in strategy, using increased debt.

EXHIBIT 5.10
SELECTED FINANCIAL STATISTICS
MERCURY PORTLAND CEMENT COMPANY

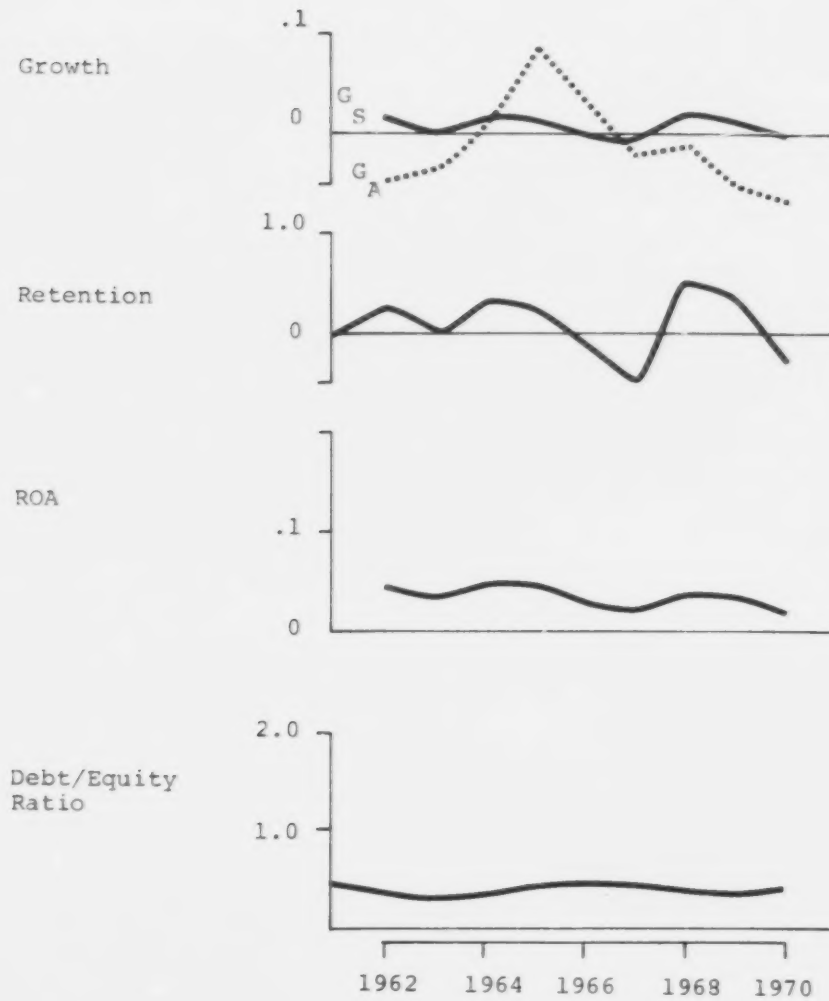


EXHIBIT 5.11

SELECTED FINANCIAL STATISTICS
VENUS PORTLAND CEMENT COMPANY

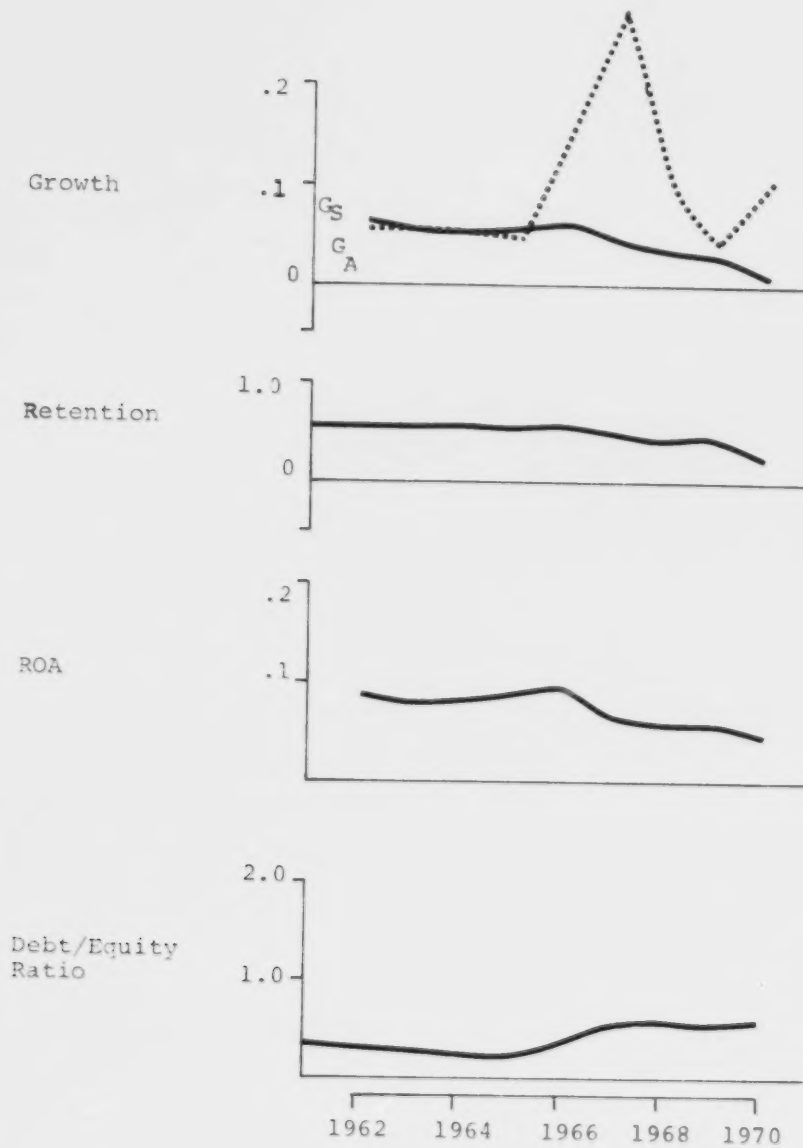
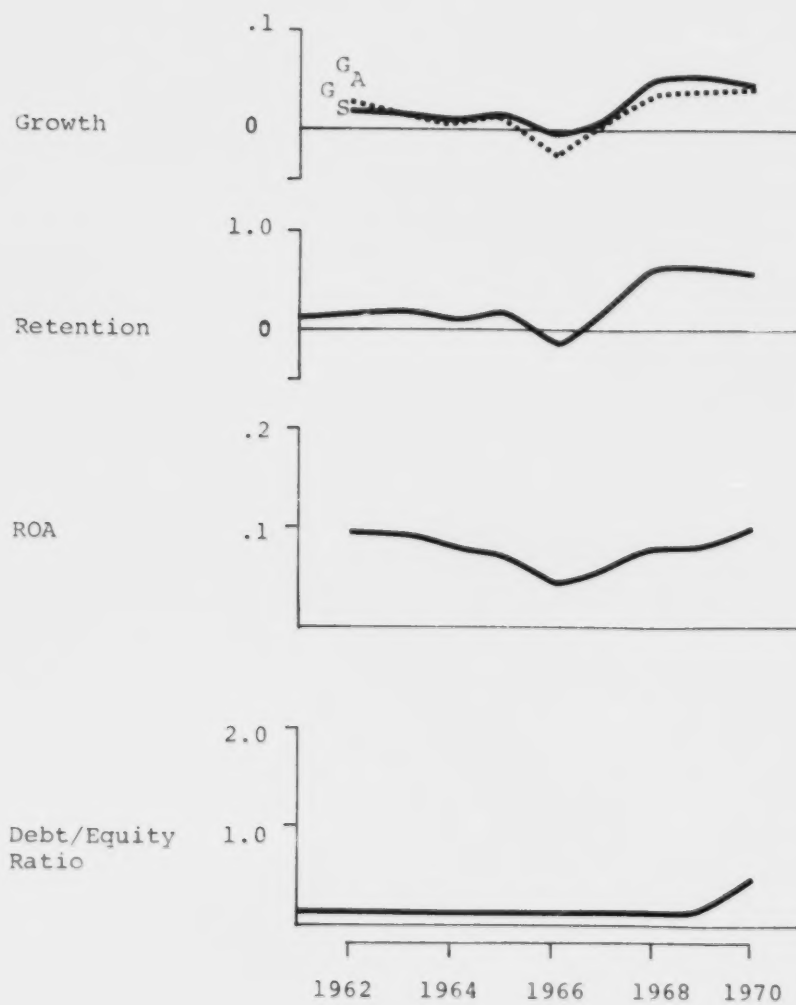


EXHIBIT 5.12
SELECTED FINANCIAL STATISTICS
THE GOOD EARTH PORTLAND CEMENT COMPANY



Debt policy was constant at about 0.12 debt ratio for years, until in 1970 the company increased its debt sharply. Good Earth Portland Cement operates in some of the faster growing cement-use regions of the U.S., and seems to have adopted financial policies which allow it to finance the maintenance of its leading position, perhaps to improve it.

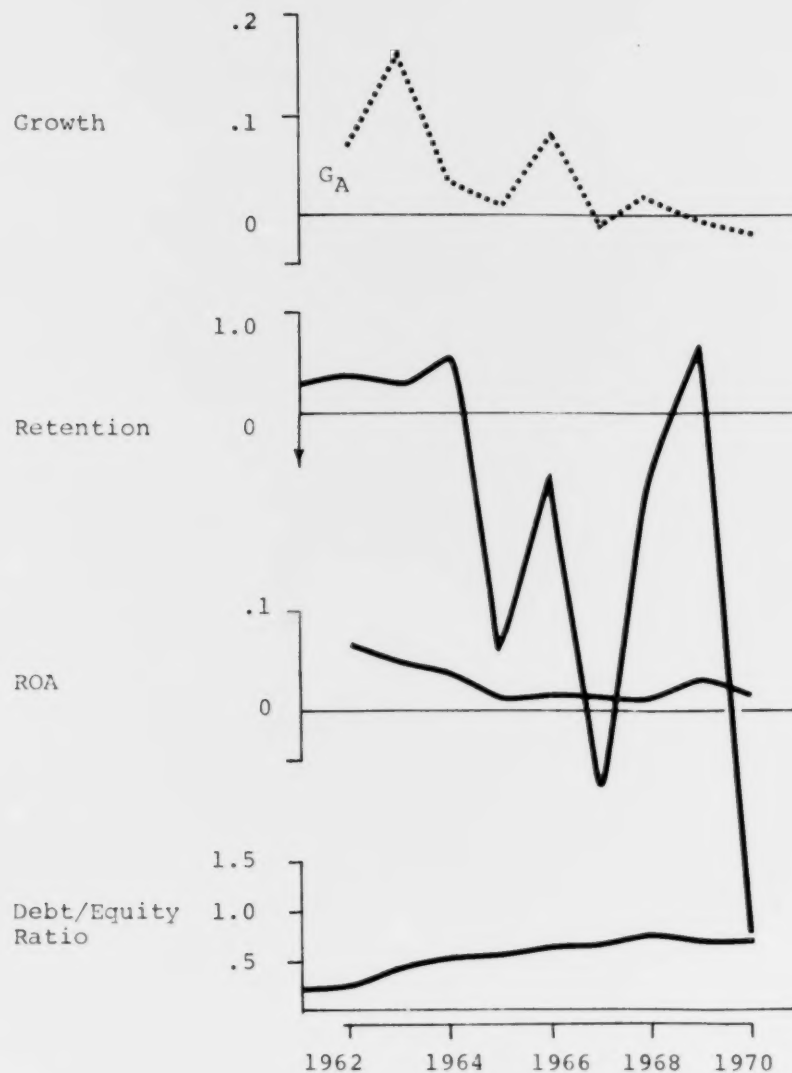
Mars Portland Cement Manufacturing Company (Exhibit 5.13) stands in stark contrast to Venus and Good Earth Portland. During the past decade that company has paid in dividends far more than its total earnings. Debt ratio has risen steadily. While the positive earnings retention through 1964 and increasing debt ratio allowed the company to grow at a rather high rate, the dividend payout thereafter offset the still growing debt usage, and growth has dropped off substantially. Return has reached a low level, and with no growth in market position, is unlikely to improve. Much of the increase in debt since 1964 has gone into dividend payments. Mars is clearly liquidating its position in the cement business, and will undoubtedly shut down one plant after another as they cease generating cash, quite independently of the effect of pollution controls.

Jupiter Fine-Ground Portland (Exhibit 5.14) and Saturn Cement Company (Exhibit 5.15) have strikingly similar patterns. Both show a steady decline in earnings retained, and both have very stable debt policies. For each, sustainable growth has declined; so has, on trend, actual growth. Both companies show declining returns which caused their declines. The reduced return seems to be weakening their financial resources as they maintain dividend payments (and increasing payout ratio) in the face of adverse earnings trends.

Neptune Portland Cement Company (Exhibit 5.16) shows a rapidly declining return, less as a function of financial policy than of its dependence on a competitive, export-dependent area. The general softening of prices hurt the company's historically high earnings. Return on assets dropped further when, in 1965 and 1966, the company adopted a policy of replacing its older, outdated facilities with new, well controlled manufacturing equipment. This expenditure was largely in borrowed funds, as shown by the marked increase in debt ratio. The company is now reducing the debt ratio slowly, accounting for the higher fraction of earnings retained.

EXHIBIT 5.13

SELECTED FINANCIAL STATISTICS
MARS PORTLAND CEMENT MANUFACTURING COMPANY



Note: G_S omitted because of dividend policy

EXHIBIT 5.14

SELECTED FINANCIAL STATISTICS
JUPITER FINE-GROUND PORTLAND COMPANY

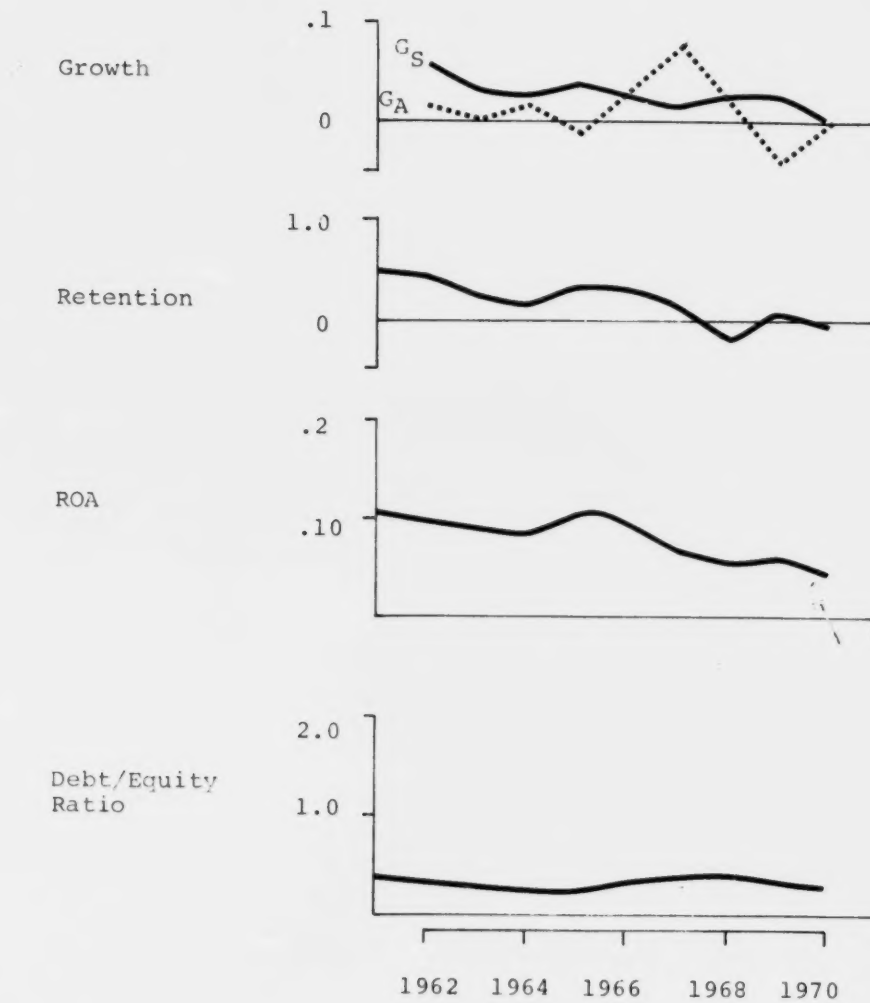


EXHIBIT 5.15

SELECTED FINANCIAL STATISTICS
SATURN CEMENT COMPANY

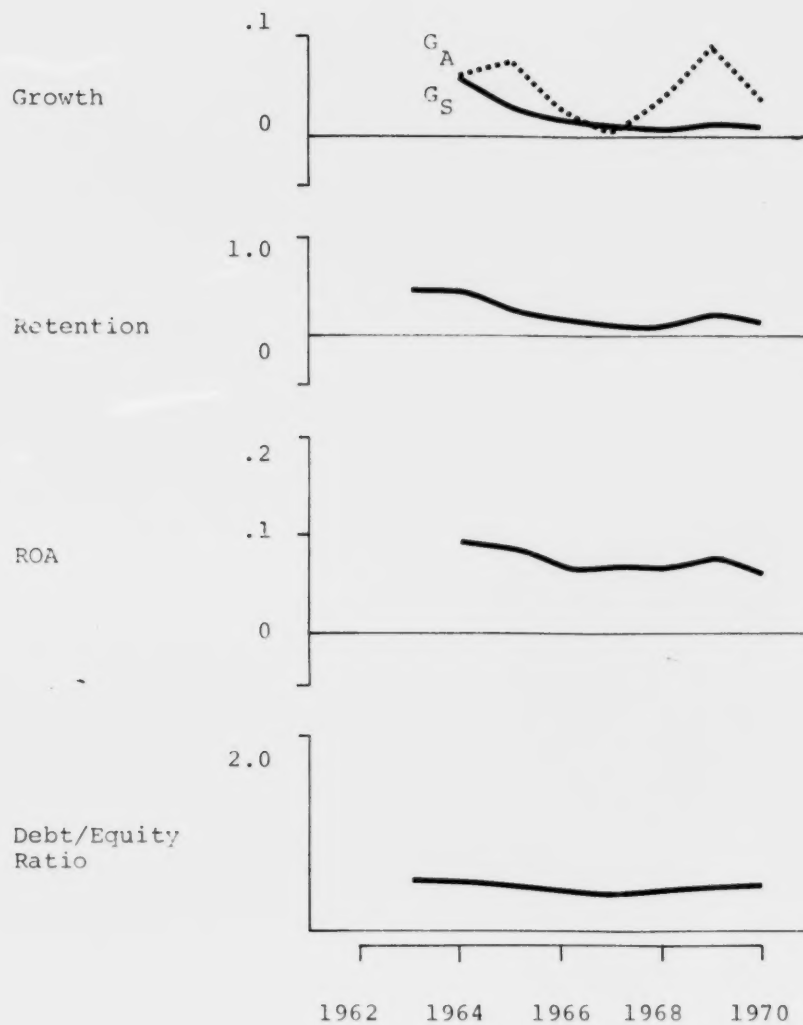
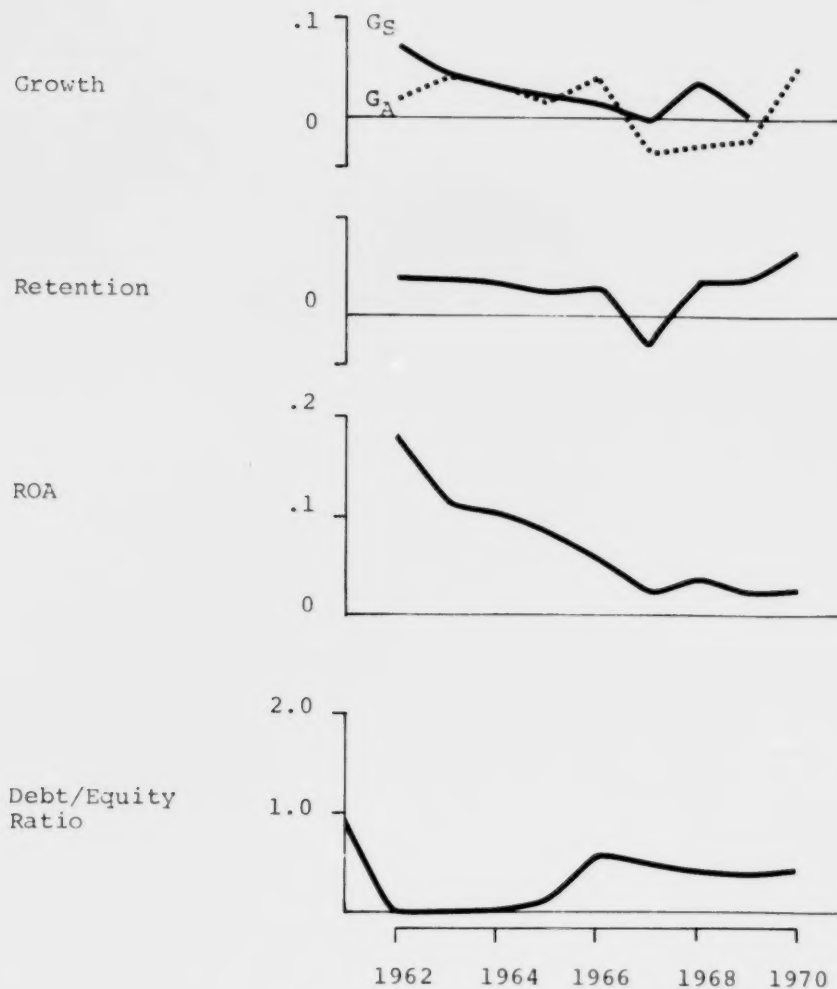


EXHIBIT 5.16
SELECTED FINANCIAL STATISTICS
NEPTUNE PORTLAND CEMENT COMPANY



Uranus Cement Company (Exhibit 5.17) seems also to be in a process of slow liquidation. In contrast to Mars, Uranus is slowly paying off its debt. The negative marginal debt ratio offsets the earnings retention, and sustainable growth is quite low. Uranus seems to have suffered the combined effects of price erosion and loss of position, with rapidly and steadily dropping returns. Uranus, however, retains the option of a reversal in financial policy, if industry prices improve enough for its profits to cover an increased level of debt for new plant investment. Barring such a change, it is difficult to see how Uranus can continue long to operate its plants.

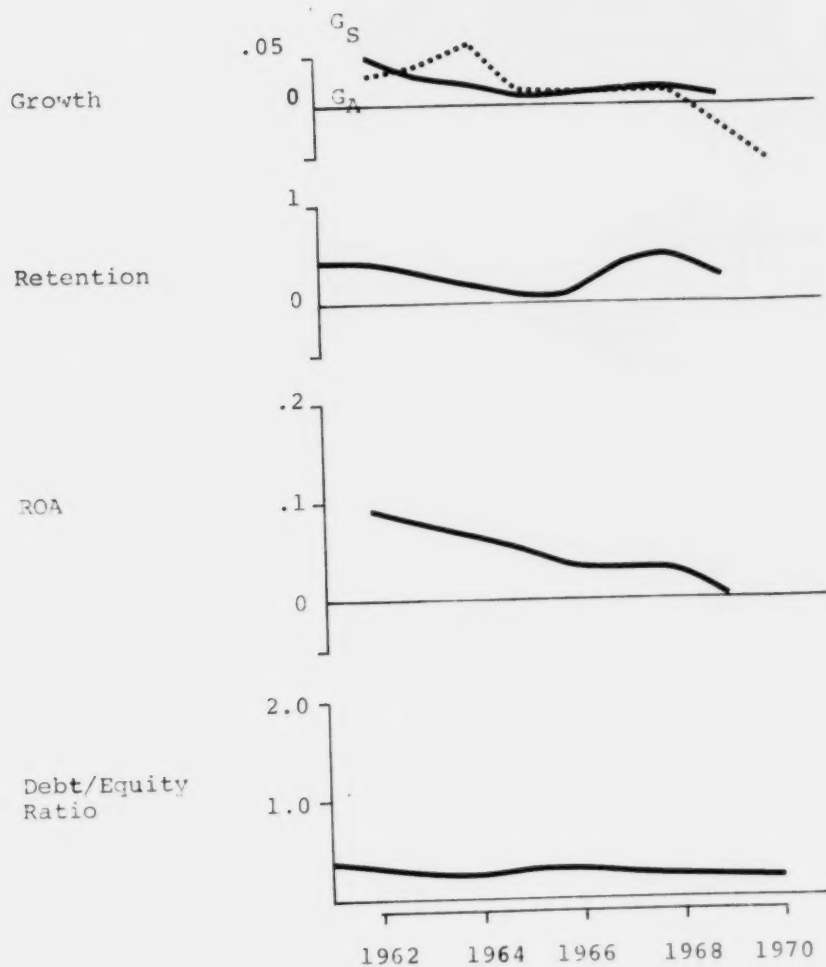
A word or two of caution is in order about the preceding comments on specific companies. They do not imply criticism or recommendation of any company's policies or judgments; they are only intended to illustrate that financial policy can be deduced from public information, and that it has a profound bearing on operating results and competitive strength. Clearly, too, such a brief review can be only superficial at best, and may miss important factors. These observations do serve, we think, to show that companies within the cement industry do show markedly different financial behavior patterns, and those patterns correlate well with growth and profitability. We have not singled out the companies discussed for any reason other than that they are a representative group in terms of operations throughout the nation, size, capacity, single plant and multiplant, and a wide variety of other characteristics; other company groupings could be used as well, with similar results.

For some of these companies, there is distinct evidence of changes in policy, not yet reflected in these rather encompassing figures. Managerial decisions have long time horizons; their impacts last and last. The present conditions of nearly all companies illustrated are the consequences of decisions made many years ago. In some cases, the management groups have been replaced. The new managements are acting to improve their company's future, so that simple extension of these trendlines may be a misleading approach to evaluating coming performance.

POLLUTION CONTROL COSTS AND FINANCIAL RESOURCES

Pollution control costs are both large and small. In terms of capital outlay, they are large-severe, for some of the marginal companies in the industry. In terms of operating costs, they are small; amortization of the investment is the

EXHIBIT 5.17
SELECTED FINANCIAL STATISTICS
URANUS CEMENT COMPANY



largest fraction of operating cost, with power and maintenance no more than one-third of that level. This is consistent with the existing operating cost structure, and so will only affect the total manufacturing cost but not cost mix.

The important aspect of cost is distinctly the capital needed. The cost of pollution control ranges from 8-19 cents/year per barrel produced, depending on age and nature of plants. This would be about a 3.7 to 6.1 percent increase in the produced cost, requiring a corresponding price change. The higher levels of cost would occur for the smaller, more marginal plants. It is doubtful that industry prices would rise enough to allow them to recover that cost, due to the very high profit that would give to low-cost-of-control companies; competition among them would keep prices down, forcing out the marginal plants even if they could raise the initial capital. Prices can be expected to rise 8-10 cents per barrel or about two percent, absent any controls other than competition.

The burden of pollution control expenditures will fall on large companies, and companies with large plants. Companies with small plants will elect not to invest in controls, but instead to shut down. Because of their low-return cost structures, they would be unable to raise the funds in any event. The loss of an otherwise productive plant is a burden, to be sure, and particularly when the loss is abrupt. Yet it is evident that the choice is between a lingering demise or a fast one. We can be sure that the operators of marginal plants would prefer to linger, generating whatever cash they can, as competitors grind them down. But subsidizing their survival works a disservice to the companies who have shown a pattern of sustained investment in the industry, who have developed and used their financial resources, and who are willing where possible to make additional expenditures to depollute. This leads to a conclusion that there seems to be no great need to provide price supports, loans, special depreciation, or other relief to the cement industry. (Appendix 4 shows the cash-generating capability of the industry versus new plant needs.)

There may be no excess of financial resources in the industry, but there are many examples of companies within and outside the industry who have provided financial resources sufficient to match investment opportunities. It is clear that investment opportunity exists, in the cost differential

between old and new, small and large, manual and automated plants. The opportunity is tempered by increasing distribution costs as plants get larger, though the record shows a net advantage yet remains. The opportunity may be further diminished by the front-end cost of pollution control, but adequate returns are yet available.

Some of the burden of pollution control costs will be paid by direct equity investment, as earnings are withheld rather than dividended to pay for controls. This has clearly been the case for several large companies whose depollution programs have not been accompanied by increased debt. There is a limit to this source of financing, though, both in terms of available earnings and the minimum dividends shareholders will tolerate.

Some of the cost of pollution control must be paid for by increased debt. Debt increases financial risk. The only companies that can afford more debt are those whose earning power is high, and whose operating cost structure has the least cost leverage. Again, those are the companies who operate or build large, modern plants (where, it will be recalled, the fixed cost ratio declines and average unit costs at full capacity are well below small, old plant average costs).

Inevitably, we can expect to see the cement industry increasingly turning to larger plants, and more debt in capital structure to finance these plants. As the plant mix changes, the industry as a whole can safely carry a greater average debt ratio. It appears that as this potential for change in financial structure is recognized, the high levels of marginal debt which will be raised will pay for the new plants and their controls.

This is not a perpetual condition. As the cost of new pollution control equipment is recovered through depreciation, cash flow will increase. Newly added debt can be retired. Over time the total cost of plant will be higher, as will the cost of operations, and this will be reflected in a somewhat increased price for cement. Price levels of four to five percent above otherwise normal levels can be expected as a result. The primary effect on financial resources of the industry will be transient, but severe for some companies. For that reason we can expect pollution control legislation to lead to some permanent dislocations in competitive position, within an industry which will, on balance, be able to meet its needs for financial resources.

CAPITAL NEEDS AND RESOURCES, 1971-1980

The trend toward modernization and expansion of existing plant sites will gain additional impetus from the simple economics that it is cheaper to make cement that way. A very large amount of capacity must be built, and the financial resources of the industry will be strained to meet the needs. Faced with a greater rate of capacity growth than during the last decade, corporate treasurers will double their efforts to hold down the unit costs of new plants, by urging the expansion of existing facilities wherever possible.

It appears that the industry can meet its capital needs, based on reasonable projections of capital costs and cash flow. Any projection of the future is a hazardous undertaking at best, particularly when so many interrelated factors must be considered. These include demand growth, price levels, capacity utilization levels, retirements of old plant, new construction costs, industry profitability, and the amounts of depreciation taken. Nevertheless, it is possible to make reasonable estimates of these factors, perform the analysis, and then test for the sensitivity of the results to changes in the input factors.

The cement industry has three primary sources of capital which can be used to support new construction: depreciation, retained profits and the increased debt which the company can support. New equity issues are a fourth possibility, primarily for companies with great success in using their other sources of investable funds. The ultimate source of all funds is of course the profits from cement sales which remain after all costs have been deducted from revenues. Depreciation is treated like a cost in that it is deducted from sales to arrive at net profits, but unlike the other costs it involves a previous cash outlay. Depreciation charges act as a source of cash because they allow the recovery of past investments from current revenues.

We can estimate these sources of cash for the cement industry by extrapolating from a representative sample of companies. Return on sales, retention policies, and debt/equity ratios were projected based upon the actual average three-year results for seven companies with about one-third of industry capacity. The seven companies selected for the sample results include both large and small firms. These companies have shown investment policies ranging from aggres-

sive construction of new capacity to reduction in capacity and liquidation of market share. The primary reason for their selection, aside from the fact that they represented the different types of firms engaged in the cement business, was that these firms are engaged almost exclusively in cement manufacture. Many of the other larger cement firms have diversified portfolios or are part of larger companies engaged in other businesses. Those selected, with one minor exception, have no other activities, so the income and balance sheet results are derived solely from cement operations.

The amount of capital spending which will be required is highly sensitive to the number of old facilities which will be closed down over the next ten years. Since replacements of these facilities do not add to total capacity, they will increase the industry's capital outlays without alleviating the supply needs. On the other hand, the new facilities have far lower operating costs than the old facilities which they replace. Figures shown elsewhere in the study (Exhibits 5.1 and 5.2) indicate that old plant cash costs are considerably higher than those in a new plant. These savings will more than offset the increased depreciation and interest costs of a new plant.

Our analysis postulates three possible levels of plant retirements. These are based on 25, 50, or 75 percent of the plants, classified in 1971 as both small (defined as under four million barrels) and old (built or last remodeled before 1960), being closed down in the five-year period 1971-1975. This is the same as closing 8, 17, or 25 percent of all 1971 plant capacity.

There were also separate analyses performed for a high demand growth and low demand growth. The two levels of demand were both based on the relationship of cement shipments of constant dollar construction expenditures. (This is discussed fully in Section 4.) The detailed analyses are shown in Appendix 4, and the results are summarized in Exhibit 5.18. Constant dollar (net of inflation) prices at 1971 levels were used.

The cash needs for the five year period 1971-1975 can vary from a surplus of over \$150 million after investment to a shortage of more than \$370 million. The primary cause of the wide variation is differing assumptions about the amount of existing but obsolete capacity which will be closed rather than be upgraded by the installation of pollution control equipment. Increasing the level of retirement

from 25 percent to 75 percent of the small, old plants in 1971 raises the cash needs by about \$400 million. Raising the demand estimate also increases the cash needs because more capacity must be built to meet the higher demand levels.

The important question for this study is whether additional pollution control costs will have a significant impact on those cash flows. Clearly they can. The most biting effect of pollution control costs is that they will force old plants to close sooner than they otherwise would. As we have just seen, the effect of closing 75 percent of pre-1960 plants by 1975 is \$400 million greater net cash needs than closing only 25 percent of those older plants. The industry goes from a net cash generator to a cash user; in other words, with 25 percent retirements dividend payout could be increased, but with 75 percent retirements dividends must be reduced or eliminated and additional debt burden assumed.

That is the biggest effect of pollution control legislation. It will force modernization of the U.S. cement industry at a faster than normal rate, causing a substantial need for cash.

The cost of pollution control is therefore much larger than just the incremental equipment, engineering, and installation cost to bring plants up to standard. Those capital costs have been estimated at \$96.6 million by the E.P.A., and at a somewhat higher figure of about \$215 million by the industry (which includes spending for all legislation, not just the 1970 amendments to the Clean Air Act). The real cost of pollution control to the cement industry is the cost of forced-draft modernization of a manufacturing system which has components ranging in age up to 75 years.

We must strongly emphasize that the replacement of old, obsolete capacity with modern efficient plants will have significant benefits to offset the cost of new construction. The cash savings resulting from lower operating costs in the new plants will result in a better competitive posture vis-a-vis foreign competition.

In our analysis a higher demand assumption results in an even greater cash shortage. Greater demand will usually result in higher prices, however, which will provide more resources for new construction. Sustained levels of strong demand, and the expectation of continued high demand, makes lenders and investors far more willing to provide funds, either in the form of debt or new equity. Corporations with other interests are more likely to be willing to provide funds for their cement operations if demand is strong.

Whatever is the rate of demand growth and plant replacement, the need for new capital will not be spread evenly over the firms currently in the cement business. Those companies which have allowed their portfolio of physical assets to deteriorate and now hold many small, old plants will be faced with larger cash needs than companies which have invested in the past in new plants. Past financial policies will also affect the ability of firms to meet the cash requirements to construct new facilities. Overall, however, there remains a serious question of whether the industry can meet the potential cash deficits.

Examination of the sensitivity analyses (Appendix 4) indicates the effect of changes in financial policy on cash available. Exhibit 5.18 summarizes the results. For example, an increase in earnings retention from 41 percent (the industry average) to 51 percent of after tax profits, coupled with an increase in marginal debt/equity from .39:1 to .49:1, results in \$70 million in additional cash available investment over the five year period 1971-1975. Increases in return on sales have an even greater impact. Adding just one percent to return on sales (about 3.5 cents/bbl.) adds \$77 million to after tax profits during the five year period. The combined effect is, depending on demand growth, \$147-153 million.

If the industry has to meet our most severe projections for cash needs, an additional \$400 million must be raised over and above normal cash flows from depreciation, retained earnings, and today's debt/equity ratios. That means either an influx of outside capital or a change in financial policy. It appears that changes in financial policy alone will be sufficient.

Exhibit 5.18 shows a cash surplus of \$27 million under conditions of low plant retirement and high demand. Presumably this would go into increased dividend payout ratios, or investment in other businesses, under normal conditions. If the industry as a whole makes no change in financial policy, that \$27 million is available for more rapid replacement of plants. Dividends would still rise, measured in dollars, paralleling the industry's growth; but the payout ratio would be constant at 59 percent of earnings.

Reducing the payout ratio to 49 percent of earnings from the present 59 percent would provide another \$65 million (including some increased borrowing to maintain present debt/equity ratios). So by not increasing (in fact, slightly reducing) present dividend payments the industry could pro-

EXHIBIT 5.18
CEMENT INDUSTRY CASH NEEDS

<u>Demand Growth</u>	<u>Plant Retirements</u>	<u>Industry Total Cash Surplus/Shortage (\$ Million)</u>	
		<u>1971-1975</u>	<u>1976-1980</u>
Low	Low	\$157	\$236
	Medium	(60)	298
	High	(246)	352
High	Low		
	Medium	\$ 27	\$134
	High	(191) (377)	196 250
<u>Sensitivity</u>		<u>Increase in Cash Available 1971-1975</u>	
a.	1 percentage point increase in return on sales	\$45-46	
b.	10 percentage points increase in earnings retained	64-67	
c.	10 percentage points increase in debt/ equity ratio	19	
d.	combined effects of a, b, and c.	\$147-153	

vide about \$90 million of the \$400 million needed to meet our most severe estimate of cash needs. This would still leave the cement industry with a dividend payout close to the average of U.S. business.

The balance of the needed funds, if they are to be generated internally, must come from an increased level of debt/equity ratio. By extrapolation from our seven sample companies, the cement industry at the start of 1971 had about \$1,113 million equity and \$435 million debt. With the above change in dividend payout, equity by the end of 1975 will be about \$1,350 million, and debt about \$530 million. Raising this by \$310 million would provide the needed cash, and raise the industry's debt/equity ratio to 0.62:1. That would be a heavy burden, but not unmanageable. During the next five years the industry would be able to repay about \$250 million of that amount, easily restoring the historic debt ratio.

To keep in perspective what this really means, our most severe projection calls for rebuilding and expanding a total of 202 million barrels by 1975--a prodigious undertaking, probably beyond the bounds of practical possibility. Yet the industry could finance that growth without a substantial price increase (in real terms). Surely if demand grew so rapidly, and pollution control forced so many plant closings, some short-term price increases would occur. The cash generating capability of the cement industry is highly leveraged by small changes in price. We have seen that a one percent change in mill net, which is about seven cents per barrel in user price, provides \$77 million to the industry over five years. That is less than a two percent price increase.

It seems very clear that a four to five percent real price increase, plus modest changes in debt and dividend policy for five years, will allow the industry to finance internally the maximum expected market growth, the maximum expected plant closings, and all required depolluting of existing plants which will continue to operate. Again we must stress that while the industry can manage these costs without external capital, that is not true for every firm. Moreover, to handle the costs of pollution control and growth, the industry will have to change its financial policies in the direction of less dividend payout and more debt. For some companies, the magnitude of change required may be more than their present stockholders will tolerate. Finally, a price increase of as much as five percent, in real terms, may be required to finance the transition (although thereafter we would expect to see prices fall, in response to reduced operating costs).

The result of this process will be a good deal of pain for many cement companies. It may be terminal for some. But the industry will be more modern, more efficient, and quite probably more profitable when the change is completed. The rising flow of imports may well be stopped. Some companies will benefit far more than others, creating great investment rewards for insightful and courageous investors and corresponding rewards for company managements.

Section 6

CEMENT DEMAND, FOREIGN TRADE AND EMPLOYMENT IMPACT

SOURCES OF CEMENT DEMAND

Shipments of portland cement by U.S. producers in 1970 totaled 390 million barrels. This was down from the record 409 million barrels shipped in 1969. The U.S. demand for cement has shown a steady increase since World War II. Shipments increased in every year since 1945 except for four years (1957, 1960, 1967, and 1970).

Cement can be regarded as a commodity which is being sold principally on a price basis. The specifications for a particular type of cement are closely regulated by an independent body (the A.S.T.M.) and all cement must meet these performance standards. While service and delivery are factors in choosing a supplier, price is generally conceded to be the overriding determinant. While cement is sometimes sold on long-term contract, industry sources indicate that the customer may for all practical purposes change suppliers at any time without penalty.

Demand for cement has been difficult for producers to affect in the short run. It is basically a derived demand dependent on the level of new construction. Cement being a very small part of total construction costs, short term reductions in cement prices will increase neither the total volume of construction nor the utilization of cement. In most applications there are no suitable substitutes for concrete in any case.

The economics of production encourage the retention and utilization of obsolete plant facilities. A cement plant once in place requires a relatively small variable cost to keep it operating. Declines in demand are met with price declines as producers try to keep their facilities operating. These price cuts do not substantially affect total demand but do result in lower industry returns. On the other hand, when demand rises over the long term and shortages develop, several years are required to construct new plants.

Demand for cement can be closely correlated with certain other factors in the economy. Since all cement produced is used directly or indirectly in construction, the demand for cement is closely correlated with construction indices. The following table shows that barrels of cement consumed (shipments + imports - exports) are closely correlated with expenditures on new construction (constant dollars). The increasing trend between 1967 and 1970 and the fact that cement prices have risen less than those of most competing building materials may indicate a shift from single family units to multifamily dwellings; the former utilize less concrete per dollar of construction cost than the latter. If this trend continues future demand for cement will rise more quickly than construction expenditures.

RELATIONSHIP BETWEEN CEMENT CONSUMPTION
AND NEW CONSTRUCTION EXPENDITURES

	New Construction Put in Place (In 1957-1959 \$ Billion)	<u>Portland Cement</u>	
		Consumption (in millions of barrels)	Barrels per \$1,000 of New Construction
1952	\$42.90	248.70	5.8
1953	44.70	258.74	5.8
1954	47.20	273.51	5.8
1955	51.72	296.23	5.7
1956	50.03	311.18	6.2
1957	49.88	292.80	5.9
1958	50.27	309.85	6.2
1959	54.22	340.54	6.3
1960	52.17	316.22	6.1
1961	53.09	324.14	6.1
1962	55.95	337.18	6.0
1963	58.10	352.77	6.1
1964	59.17	369.22	6.2
1965	62.90	378.86	6.0
1966	62.94	386.70	6.1
1967	61.14	378.93	6.2
1968	64.43	403.83	6.3
1969	64.20	418.00	6.5
1970	60.20	403.00	6.7

Source: Francis Carey and William Price "A Review of the Cement Industry", Reynolds & Co., April 1970.

New construction expenditures were deflated to constant dollars in the above table to analyze better the relationship between the amount of cement employed and a specific physical volume of construction. In the table, \$1,000 of construction should represent the same amount of physical building in each year. Similarly, by restating cement prices in constant dollars it may be seen how prices behaved when looked at using a uniform measurement over a long period of time. (See Exhibit 6.1.) The sharp increase in constant dollar prices for cement during the 1950's followed by sharp declines during the 1960's had essentially no effect on the relationship between cement demand and construction expenditures.

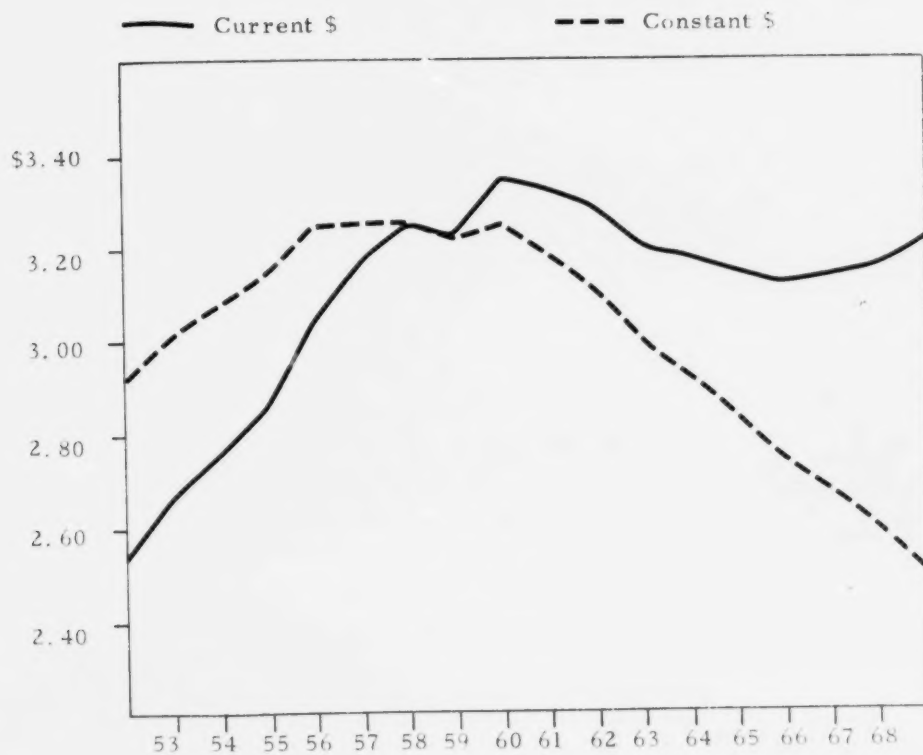
The stability of cement usage in relationship to a gross construction index would indicate that changes in cement prices within a relatively narrow price range will not have a substantial effect on the demand for cement. Over a long period of time, however, substantial variations in cement prices as compared to alternative materials will affect broad usage statistics. A 1959 study of the cement industry indicated that efforts at price stabilization by cement producers in the 1930's resulting in higher mill prices, contributed to a large expansion of the production of petroleum asphalt.

The relative insensitivity of cement demand to small price fluctuations can be explained by the nature of its uses. While in highways and high rise building concrete may be replaced by asphalt and structural steel, for most other cement applications there are no practical alternatives. This is true for such uses as foundations, high dams, bridge abutments, pilings, runways, high strength floors and the like. For these applications the compressive strength, low cost, and formability of concrete leave little alternative to its use.

The highways market accounts for about 19 percent of total cement demand, but this is heavily concentrated in the interstate program. While only 8 percent of all highway construction is concrete, about 56 percent of the interstate program is concrete. In those roads, where extensive use by heavy truck traffic is anticipated, the superior durability of concrete favors its use over asphalt.

A second reason for the relative insensitivity of cement demand to price is the relationship of the cement cost to the cost of the finished construction in which the cement is utilized. The cost of the cement is a very small component in the total cost of construction. The principal cost is the labor involved in preparing forms and pouring. For example in

EXHIBIT 6.1
CEMENT AVERAGE REALIZED MILL
PRICE PER BARREL



the New York City market the cement needed for one cubic yard of concrete costs about \$6. The cost of a cubic yard of the concrete ready to be poured runs \$18-22 while the cost of the same cubic yard in place is \$90-100 in a reinforced concrete structure. The value added is in the forms and labor. For nonreinforced concrete the in-place cost runs \$40-50 per yard.

The cost of the concrete is even a smaller part of the cost of the finished project. An industry rule of thumb estimates one cubic foot of concrete for each square foot of finished floor space in a reinforced concrete structure. The cost of the cement in a cubic foot of concrete is about 23 cents. Building costs for high rise reinforced concrete office structures are currently running \$43-45 a square foot in the Boston area (F.W. Dodge Reports).

Small changes in the cost of cement are therefore unlikely to have a significant impact, in percentage terms, on the total cost of construction. The slightly increasing trend in cement use per \$1000 of construction would probably suffer nevertheless if, as a result of pollution controls, cement prices rose substantially in relationship to those of asphalt and structural steel. The industries which produce these alternative materials are also faced with substantial expenditures to combat their own emissions. Cement should not be at a disadvantage relative to these products solely because of pollution control costs.

Construction volume is determined by such factors as the state of the economy, anticipated GNP growth rate, monetary policy as reflected in interest rates, and government appropriations for highway programs and public works. These influences are essentially independent of cement prices. Given that cement demand is derived from construction outlays, which are in turn affected by macro-economic forces, it may be concluded that minor changes in the cost of cement will not have a substantial impact on construction demand. However, they may affect the use of substitute materials in some applications.

POLLUTION COST EFFECTS ON CEMENT DEMAND

The cost impact based on the amounts required for pollution control supplied by the Environmental Protection Agency indicated cost increases of 8-15 cents per barrel. Figures obtained from the industry would indicate higher capital costs resulting in total cost per barrel per year of 17-22 cents. Cost increases of this magnitude, and the resultant price increases, should not substantially affect cement demand. Prices

of alternative materials, where their use is appropriate, should also rise in response to pollution control costs. Yet to the extent that cement prices rise proportionally more (or less) than alternative products, substitution can occur. Total cement usage could be changed in this way. Since small changes in operating rate have a large impact on cement plant profitability, pollution costs substantially different from alternative materials could have significant effects on industry profits.

At the present time the increased demand for pollution control is but one of several significant trends in the industry. First, the overcapacity situation is being alleviated. Construction of new plants slowed in the past few years and demand is quickly approaching practical capacity. As a result, prices have risen over the past year. New investments in capacity to meet this demand will be required in the next several years. Second, the growth rate of imports has been more than three times as high as the growth of domestic production for the past 15 years. Large modern European plants can ship cement by low-cost deep water transportation and effectively compete in the East Coast market. Third, a few large new U.S. plants have also expanded their marketing areas by using water transportation. These new plants have substantially lower costs than older, smaller plants. Competition from these newer plants has resulted in the closing of many old, obsolete plants in the past 10 years. The last two factors have sharply increased the competitive pressure on old, inefficient U.S. plants.

The impact of pollution controls will be felt most severely by these small old plants. They are at an economic disadvantage already and the burden of additional capital investment may be heavy. If the industry as a whole faces increased manufacturing costs as a result of pollution control legislation, then there will undoubtedly be a corresponding price increase. Our estimate is about two percent in delivered price. Such an increase will have little effect on cement demand. It will place increased pressure on smaller, older plants, however, adding to already strong competitive pressures. The net effect of closing such plants, to avoid the capital outlay, may be a short term supply shortage in some regions.

A shortage of supply has the same impact on surviving plants as an increase in demand. For them, demand will rise even though total cement usage in that region is relatively stable. With that may come local price dislocations which add to price increases caused by pollution controls. Higher prices and higher plant utilization will increase their profits sharply, accelerating the motivations to invest in new plants and to

correct any supply-demand imbalance. Overall, the impact, if any, on demand, is likely to be only transient, although the impact will appear more significant if only single plants, single companies or single years are analyzed.

FOREIGN TRADE IN CEMENT

Imports and exports of cement have historically been at very low levels, but imports have risen sharply in the past five years. The magnitude of this growth is shown in the following table. The value of 1970 imports was \$34 million.

U.S. IMPORTS OF CEMENT

<u>Year</u>	<u>Imports Million Bbls.</u>	<u>Imports as % U.S. Production</u>
1953-57 average	3.0	1.1
1960	4.1	1.3
1965	5.5	1.5
1966	7.0	1.8
1967	5.9	1.6
1968	7.4	1.9
1969	9.7	2.2
1970	13.8	3.6

Source: U.S. Bureau of Mines

Imports in 1969 by country of origin (latest available data) show that the bulk of the imports come from a very few countries. They are noted in the following table.

SOURCES OF IMPORTED CEMENT

<u>Country</u>	<u>Quantity Million Bbls.</u>	<u>Value \$ Million</u>
Bahamas	3.9	9.8
Canada	2.7	7.3
Norway	1.6	3.2
All Others	<u>1.3</u>	<u>4.0</u>
	9.7 Bbls.	\$24.3

Exports have declined steadily since 1966 and represent only a negligible fraction of U.S. production, as shown in the following exhibit. The value of 1970 cement exports was \$5.2 million. Imported cement averaged \$2.52 per barrel while exported cement was nearly \$6.50 per barrel. The cement being imported into the United States was ordinary Type I cement. Exports consist of certain high priced specialty varieties.

U. S. EXPORTS OF CEMENT

<u>Year</u>	<u>Exports Million Bbls.</u>
1960	.2
1962	.4
1964	.7
1966	1.1
1968	.9
1969	.6
1970	.8

Foreign trade in cement has historically been small because of cement's very low value per pound (under one cent a pound mill price), the high cost of transportation, and the ability of the domestic cement industry to meet offshore demand at competitive prices.

Several factors have led to the increase in imports. Large modern plants have been built overseas. These plants have the latest equipment (as do newly constructed U.S. plants), are accessible to cheap deep water transport, and have excellent limestone supplies. The economies of scale accruing to large new plants, better labor efficiency, and lower costs per hour have helped overcome the cost of shipping the cement to the United States. Partially offsetting this, fuel costs in Europe are higher. One industry source estimated deep water shipping costs per barrel from Europe at 30-50 cents per barrel, compared to labor cost savings of 40 cents per barrel. Although this seems to be a standoff, foreign cement is particularly competitive along the U.S. Eastern Seaboard where deep water cement ships may be directly offloaded into shore terminals, thus minimizing costly land transport. The following table shows the U.S. imports by customs district.

1969 IMPORTS BY CUSTOMS DISTRICT

<u>District</u>	<u>Import Quality (Million Bbls.)</u>
Miami	2.0
Tampa	1.5
Buffalo	1.4
New York	1.2
Norfolk	.7
All Others	2.9
	<u>9.7</u>

Tariffs on foreign cement (excluding the current ten percent surcharge) are small, but add to the cost. The duty on regular portland cement is 1.3 cents per hundred pounds (4.9 cents a barrel); this is scheduled to be eliminated December 31, 1971. Despite the apparent cost equalization factors, foreign cement currently sells in the United States for 25 cents per barrel less than domestic cement. That is the spur to import growth.

To obtain this discount, however, the customer must accept a degree of uncertainty of delivery. Cement is shipped from Europe only when an ore or coal boat from the U.S. is ready to make a return trip. Since ships might otherwise return with ballast, shipping cost may be more apparent than real. Because importers' storage facilities in the country are small (about 60,000 barrels for the largest importer according to an industry source), there is a little cushion against stockouts and nondelivery. Importers have been reluctant to invest in the high cost of storage facilities since the supplies from overseas are still dependent on available shipping and excess capacity in foreign plants.

The economics of transporting cement into the United States are unquestionably favorable. Bulk carriers travel to foreign sites loaded with coal or ore. On the return trip ballast is needed, and the cement is used in place of water. We do not know if foreign cement firms are integrated into shipping, or if the freight companies are passing savings back to the cement companies. It has not yet been determined if

the freight rates cited actually involved cash outlays, either to outside firms or in variable shipping costs.

To the extent that pollution controls raise prices in the U.S., foreign imports will become more competitive in this country. Only preliminary data have been obtained on pollution control requirements overseas. This information indicates that Canada, the U.K. and Norway have strict controls while the Bahamas have very few controls. The only plant in the Bahamas is owned by Universal Atlas, a subsidiary of United States Steel Corporation.

Imports can be expected to grow in any case. As the gap between capacity and demand shrinks in the U.S., prices can be anticipated to rise. This will make the U.S. market more attractive to foreign cement. On the other hand the use of deep water transportation by certain very large U.S. plants has expanded their market area and may partially offset the growth of imports.

Imports of foreign cement have risen more quickly than domestic production due to the greater efficiency of foreign plants, lower labor costs and lower cost ocean transportation. The additional costs of pollution control to United States producers will improve the relative cost position of foreign cement. If U.S. labor, fuel and power costs continue to rise more quickly than these costs overseas, increasing amounts of foreign cement will be imported. Similarly, if older high cost plants continue to supply a large portion of U.S. production, and if prices remain at a level sufficient to provide a return to these higher cost facilities, foreign cement produced in larger newer plants will be priced more attractively to U.S. customers. On the other hand if the imposition of control costs shifts U.S. production to larger, more efficient plants, the cost of control may be partially offset by better production economics in the U.S.

The import of foreign cement has the greatest impact when the cement is sold in the marketing area of a small U.S. producer without access to water transportation facilities. This type of plant is unable to ship its output long distances without incurring substantial transport costs. Therefore when prices decline under the pressure of lower cost imports, returns to the U.S. producer decline considerably. At this time larger companies with better transportation situations can relocate shipments to markets not yet affected by import competition. As imports continue to increase, this strategy will become increasingly difficult to implement.

Imports of cement are still relatively small when compared to U.S. consumption. They have been growing at 9 percent per year for the past 15 years, however, while U.S. demand has only grown at 2.8 percent per year. In certain markets such as Florida, which received one-third of all imports in 1969, the impact of imports has been severe. Clearly, though, the amounts of cement which will be imported into the U.S. in future years depend far more on wage and other factor cost increases in the U.S., U.S. tariff policy, and the extent of new cement plant construction in this country than on pollution control costs.

EMPLOYMENT IN THE CEMENT INDUSTRY

Demand growth and the amount of demand supplied by imports have an obvious effect on employment in the cement industry. Yet these effects are far overshadowed by the impact of technological improvements and plant size increases which have kept the cement industry as a low and declining labor utilization industry.

The cement industry in the U.S. currently employs about 27,000 production workers. Total industry employment is approximately 37,000. The number of production workers has declined continuously for the past 13 years but has changed little since 1967. (See Exhibit 6.2.) The decline in production workers took place despite a continuous increase in the amount of cement produced. This increased efficiency resulted in man hours per barrel falling from .262 in 1957 to .145 in 1969. (See Exhibit 6.3)

At the same time the average number of workers per plant has dropped from 233 in 1956 to 148 in 1969. (See Exhibit 6.2 and 6.4.) In newer plants more emphasis is placed on automation and process control computers to handle tasks which previously required production workers. In addition, the same number of men suffice to control the much higher capacity machines in a new plant, thus decreasing manhours per barrel of output.

The cement workers in the U.S. are not concentrated in any one area. The 181 currently operating cement plants are located in 40 different states. In those states where more than one plant operates, the plants are generally scattered geographically in several areas within the state to take advantage of transportation economies.

As explained in previous sections of this report, the impact of pollution control costs is likely to fall more heavily

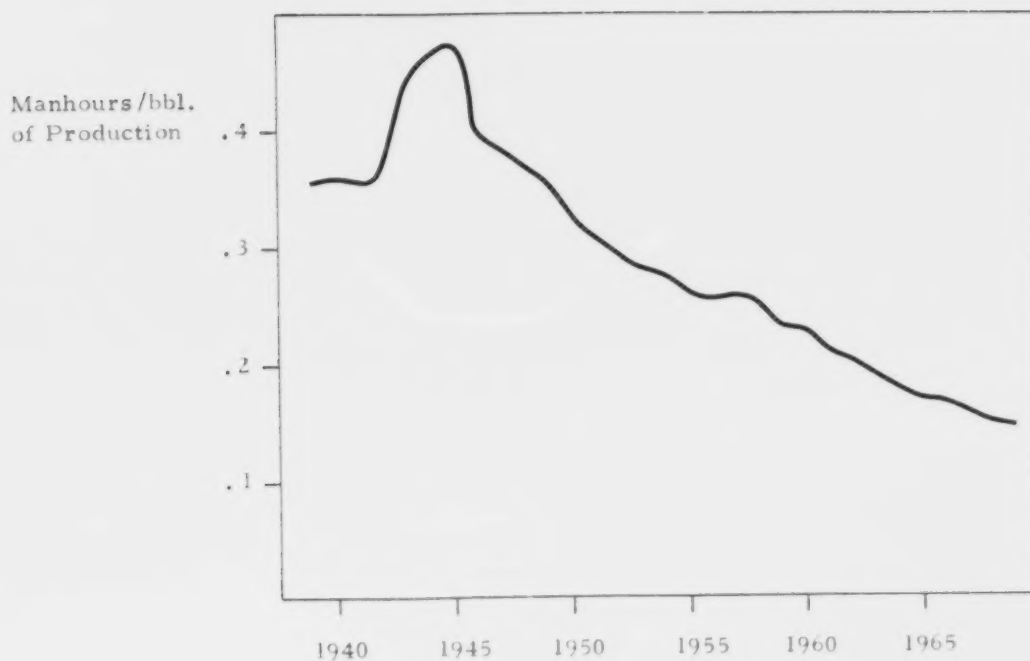
EXHIBIT 6.2

TRENDS IN LABOR REQUIREMENTS, 1939-1969

<u>Year</u>	<u>No. of Prod. Workers (In Thousands)</u>	<u>Manhours/ Bbl. of Production</u>	<u>No. of Workers Per Plant</u>
1939	21.8	0.355	139
1940	23.2	0.360	153
1941	27.6	0.354	178
1942	30.8	0.360	199
1943	26.7	0.444	175
1944	19.9	0.468	132
1945	20.1	0.475	132
1946	29.7	0.397	194
1947	33.0	0.386	220
1948	35.0	0.370	232
1949	34.8	0.358	228
1950	34.1	0.326	224
1951	34.8	0.306	223
1952	33.9	0.294	216
1953	35.8	0.280	226
1954	34.8	0.275	222
1955	35.8	0.260	228
1956	37.1	0.252	233
1957	36.4	0.262	224
1958	36.7	0.251	220
1959	36.2	0.231	212
1960	34.9	0.230	198
1961	32.3	0.210	184
1962	31.9	0.202	178
1963	30.9	0.187	171
1964	30.3	0.177	168
1965	29.4	0.169	162
1966	29.0	0.169	158
1967	26.8	0.156	154
1968	26.7	0.146	150
1969	26.7	0.145	148

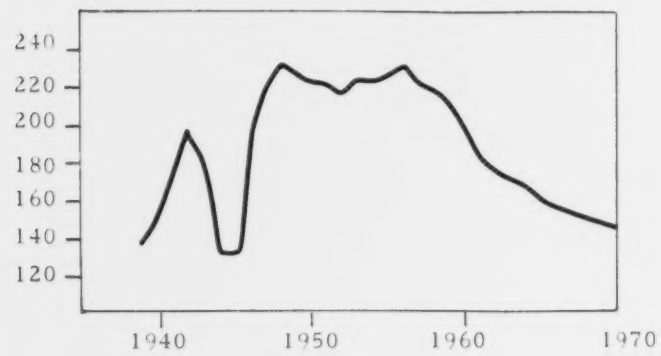
Source: U.S. Dept. of Labor. Bureau of Labor Statistics,
Employment & Earnings Statistics for the U.S., 1939-
1969.

EXHIBIT 6.3
MANHOURS/BBL. OF CEMENT PRODUCED



Sources: Rock Products, April 1968 U.S. Department of Labor
Bureau of Labor Statistics.

EXHIBIT 6.4
NUMBER OF WORKERS PER CEMENT PLANT



on smaller, older plants. The cost of operation in these plants is considerably higher than in new plants. Additional control costs per barrel may also be higher. Large numbers of these plants have closed already because of their inability to compete with newer, lower cost facilities.

It is likely, as we have said, that some small plants will be closed as a result of management unwillingness to make required pollution control expenditures. The number should not be overly large, especially when expressed as a percentage of U.S. capacity. Most of these plants would have closed in a relatively short period in any case. The locations will be diverse, and displaced employees will not be so numerous as to disrupt regional employment patterns. Some of these employees have transferable skills. These include electricians, mechanics, and heavy equipment operators. These individuals will be less affected by the shutdown of an old cement plant.

The Lehigh Valley of Pennsylvania, for example, has a larger concentration of small, old plants than any other single small area. Yet the cement industry there employs only 800 workers out of a total employed population of 50,000 workers. The impact of displaced employees would be large only in the case of an isolated town whose work force is largely employed by one old, obsolete plant. If the plant was to shut down rather than to install controls, it is likely that poor plant economics would have caused a shutdown within five years in any case. Effects on state or regional employment statistics will be minimal.

An example of serious employment impact is the Ideal Cement plant in San Juan Bautista, California. This community of 1100 persons is relatively isolated, being about 25 miles from Salinas and 50 miles from San Jose. Employment at the facility totals about 150 persons and it constitutes the town's only major employer. The plant emitted substantial visible pollutants, in excess of the amount allowed under California's air pollution code and was shut down. After the shutdown a large group of citizens petitioned the state to allow the plant to reopen. Currently it is operating under a variance which allows the company to study the costs of replacement and expansion of the plant. If the plant should be closed permanently, the nearest major communities offering employment opportunities are 45-50 minutes commuting distance away. The decision on expansion or shutdown has not yet been made.

The outlook for the existing plant was doubtful in any case, however. It was constructed in 1917 and, at 950,000 barrels rated capacity, is uneconomically small. In addition

a competing plant of 4.5 million barrels is located only 80 miles away. At best, even without any capital outlays for environmental control, the plant will be operating on "approximately a breakeven basis with rigid cost control".*

While the total employment impact of plant closings in the cement industry will be minimal, it will be felt in a few localized areas. Where pollution control requirements are the final factor in plant closings, there will be among the unemployed as much resentment about depollution as there is resentment among the general population about pollution. Such feelings about depollution, though, are probably misdirected.

Overall, the unemployment effects will be low and localized in widespread areas. For the most part, they will be felt by production workers, particularly unskilled workers. Nonproduction employees will be less affected by plant closures since over 85 percent of industry capacity is represented by multiplant companies. These companies could be expected to keep operating despite the closing of one of their plants.

* Annual Report, 1970.

Appendix 1

SELECTED INDUSTRY STATISTICS

Portland Cement Shipments by Types
Effective Versus Stated Capacity
Capacity Growth Versus Demand Growth: 1956-1962
1970 Shipments by Type of Carrier
Raw Materials for Portland Cement Production, 1969

PORTLAND CEMENT SHIPMENTS BY TYPES

	1959		1969		1970		1970 Average	
	In \$ Million*	Percent	In \$ Million	Percent	In \$ Million	Percent	Net	Mill Price
General use & Moderate heat (Type I & II)	1,012.8	92%	1,216.6	92%	1,191.2	92%		\$3.28
High early strength (Type III)	53.5	5%	47.1	4%	50.1	4%		\$3.53
Low heat (Type IV)	N	N	N	N	N	N		\$3.54
Sulfate resisting (Type V)	.7	N	7.5	1%	11.7	1%		\$3.69
Oilwell	4.1	N	11.1	1%	12.6	1%		\$3.81
White	9.8	1%	12.9	1%	12.9	1%		\$7.37
Portland-slag & pazzolan	12.9	1%	1.2	N	1.4	N		\$3.46
Miscellaneous (incl. air-entrained)	5.3	1%	16.2	1%	17.9	1%		\$4.45
Total	1,099.1	100%	1,312.6	100%	1,298.2	100%		\$3.32

N = negligible

Note: * The dollar and the percent figures have been rounded off.

Source: Bureau of Mines
1970 figures are preliminary.

EFFECTIVE VERSUS STATED CAPACITY

Caution is needed in the interpretation of capacity utilization because some of the capacity figures derived by various sources result in an overstatement of capacity.

This results from the following factors:

- Companies rate their plants when they are and calculate annual theoretical capacity usually on the basis of operating levels during the three peak summer months when maintenance is low. However, over the year about five percent of the theoretical capacity is lost because of maintenance.
- Some of the effective capacity is lost as a result of plant aging.
- Plants in the northern markets are not able to sell their cement during the entire year. About 75 percent of the annual production is shipped between the months of May and October. Since not all plants have sufficient storage capacity, the alternative is to shut down during some winter days.
- Over time the market has asked for a finer ground product which reduced the grinding capacity. As a result many formerly "balanced" plants are now lacking the grinding capacity to fully utilize their kiln output.

CAPACITY GROWTH VERSUS DEMAND GROWTH: 1956-1962
(Million Barrels)

	<u>Capacity</u>	<u>Production</u>
1956	349.4	316.4
1957	380.4	298.4
1958	402.8	311.5
1959	420.4	339.1
1960	432.9	319.0
1961	442.7	324.1
1962	468.9	336.5
Annual Compound Growth Rate (1956-62)	5%	1%

Source: Bureau of Mines

1970 SHIPMENTS BY TYPE OF CARRIER
(Million Barrels)

	(1) P to T	(2) T to C	(3) P to C	(4)=(2)+(3) Total Shipments to Consumer	(4) Percent
Railroad	45.9	8.6	61.7	70.3	18%
Truck	6.0	87.6	223.6	311.2	79
Boat	<u>42.7</u>	<u>4.0</u>	<u>6.2</u>	<u>10.2</u>	<u>3</u>
	94.6	100.2	291.5	391.7	100%
				- 1.2	Due to Rounding Error
Total U.S. Shipments				390.5	

P = Plant

T = Terminal

C = Consumer

RAW MATERIALS FOR PORTLAND CEMENT PRODUCTION, 1969

	<u>Million Tons</u>	<u>Percent</u>
Cement Rock	23.2	18
Limestone	84.2	66
Clay & Shale	12.2	9
Gypsum	3.6	3
Sand	2.0	2
Other	2.8	2
Total - Raw Material	128.1	100%
Portland Cement Production	75.5 (400 mill. bbl.)	
<u>Portland Cement</u> <u>Raw Materials</u>	= 60%	

Source: Bureau of Mines

Appendix 2

INDUSTRY ESTIMATES OF POLLUTION CONTROL COSTS

In determining the impact which pollution legislation will have on the cement industry, one of the most significant factors will be the amount of capital expenditures required at the outset of an intensified control program, and over what period these funds will be expended. In discussing the magnitude of expenditures required with industry representatives, it quickly became apparent that substantial differences exist between industry and government estimates.

The source of the differences in viewpoint is the definition of what is included in pollution control expenditures. This has several elements. From the point of view of most industry spokesmen, all expenditures for pollution control look the same. This is regardless of whether they have been made in the past, are currently planned or required by state or local codes, or whether they will be specifically required by amendments to the Clean Air Act. The E.P.A. acknowledges that the aggregate of all pollution control spending is a large figure. However, it has been specifically concerned with the economic impact of incremental spending resulting exclusively from the most recent legislation. In preparing cost estimates, the E.P.A. has deducted from the cost of controls in new plants the estimated amount of pollution control equipment that would have been incorporated in any event, for economic reasons, plant and public health motivations, or existing codes. It has reduced the estimated cost of cleaning up existing plants by the projected amounts which would have been spent on those plants without current legislation.

The Environmental Protection Agency has provided an estimate of the "direct, incremental investment required to attain environmental standards". This figure represents the investment "required to attain standards in addition to investment that had already been made prior to and during 1971". The E.P.A. estimate for the entire industry over the next five years (1972-1976) totals \$96.6 million in capital costs for existing plants, \$63 million in operating costs, and \$25 million

in interest. This amounts to about 20 cents per barrel capital cost. If all current plants are assumed to be operating in 1976, the operating cost amounts to 5 cents per barrel per year at that time.

The Boston Consulting Group asked a large number of cement manufacturers to estimate their past and projected expenditures for pollution control on a plant-by-plant basis. We have consolidated the replies, and find a high degree of uniformity of cost figures among a wide variety of companies. Their figures, based on the total costs of pollution control rather than the incremental costs of current legislation, are naturally substantially higher than the E.P.A. figures.

For purposes of analysis, the results were divided between "new" and "old" facilities. Plants constructed or substantially remodeled during or after 1960 are considered "new". All others are considered "old". Plants are also divided into "large" and "small" categories, with plants in excess of 4.0 million barrels being considered "large". The plants were also broken down between single and multi-plant companies.

The plants owned by the participants are classified as follows:

Table 1 - Barrels by Plant Type (Millions)

	<u>Small</u>	<u>Large</u>	<u>Total</u>
Old	114	36	150
New	<u>102</u>	<u>72</u>	<u>174</u>
Total	216	+ 108	= 324

Table 2 - Barrels by Plant Type (Percent)

	<u>Small</u>	<u>Large</u>	<u>Total</u>
Old	35	11	46
New	<u>31</u>	<u>23</u>	<u>54</u>
Total	66	+ 34	= 100%

Table 3 - Plants: Single and Multiplant Companies

	<u>Single Plant</u>		<u>Multiplant</u>		<u>Total</u>
Million Barrels	41	+	283	=	324 million barrels
Percent	13	+	87	=	100%

Data on 115 different plants of the 180 in the U.S. were suitable for inclusion here.

Table 4 - Control Expenditures, by Plant Type

<u>Plant type</u>	<u>\$/barrel Already Expended*</u>	<u>\$/barrel of Projected Expenditure</u>	<u>Total Required Expenditure</u>
New large	\$.48	\$.43	\$.91
New Small	.52	.35	.87
Old large	.39	.45	.84
Old small**	.33	.50	.83
All new	.48	.36	.84
All old	.37	.52	.89
All large	.45	.44	.89
All small	.42	.43	.85

Notes: * Amounts spent on capital equipment to control pollution 1962-1971.

** Two companies, representing a substantial amount of capacity were significantly higher than the rest of the industry in their estimates of the amount to be spent for emission control on small old plants. Exact capacities must be concealed to avoid disclosure of confidential information. Their results are shown separately to avoid the distortion of the industry figures (Table 5).

Table 5 - Control Expenditures: Old Small Plants, Two Divergent Companies

	<u>\$/barrel Already Expended</u>	<u>\$/barrel of Projected Expenditure</u>	<u>Total Required Expenditure*</u>
Company A	\$.75	\$1.26	\$2.01
B	.20	1.18	1.38
All others	.33	.50	.83

*Either these firms have overestimated the cost of meeting the control requirements or the other 34 firms who provided cost information have substantially underestimated the cost of control. The results of the two firms are excluded from the "old small", "all small" and "all old" categories.

The results appear consistent with the exception that "new small" plants (Table 4) have a slightly higher combined cost (\$.87) than the "old small" plants (\$.83). The projected incremental expenditures on new small plants (\$.35) are not as large as those for old small plants (\$.50), however.

Costs for the entire industry may be estimated by extrapolating from these results. The total projected expenditure for all plants responding is \$140 million spread over 324 million barrels. (This excludes the two divergent companies.) Projecting this figure over the current industry capacity of approximately 500 million barrels gives a total projected future cost of \$216 million, which is \$119 million above, or 2.2 times, the government estimate. In other words, the E.P.A. figures seem to imply that about 55 percent of the industry's anticipated spending would have been required regardless of the amendments to the Clean Air Act.

Another way of estimating total costs is to divide total existing capacity into large and small facilities (Table 6), and use the previous figures to estimate costs. The result is substantially the same when computed this way.

Table 6 - Estimated Total Incremental Costs of the Entire Industry for Emission Control, Extrapolated from Table 4.

	<u># Plants</u>	<u>Capacity (Million Barrels)</u>	<u>Incremental Cost Per Barrel*</u>	<u>Incremental Cost (\$mm)</u>
Large	33	193	\$.44	\$ 85
Small	<u>147</u>	<u>307</u>	<u>.43</u>	<u>132</u>
Total	<u>\$180</u>	<u>500</u>		<u>\$217</u>

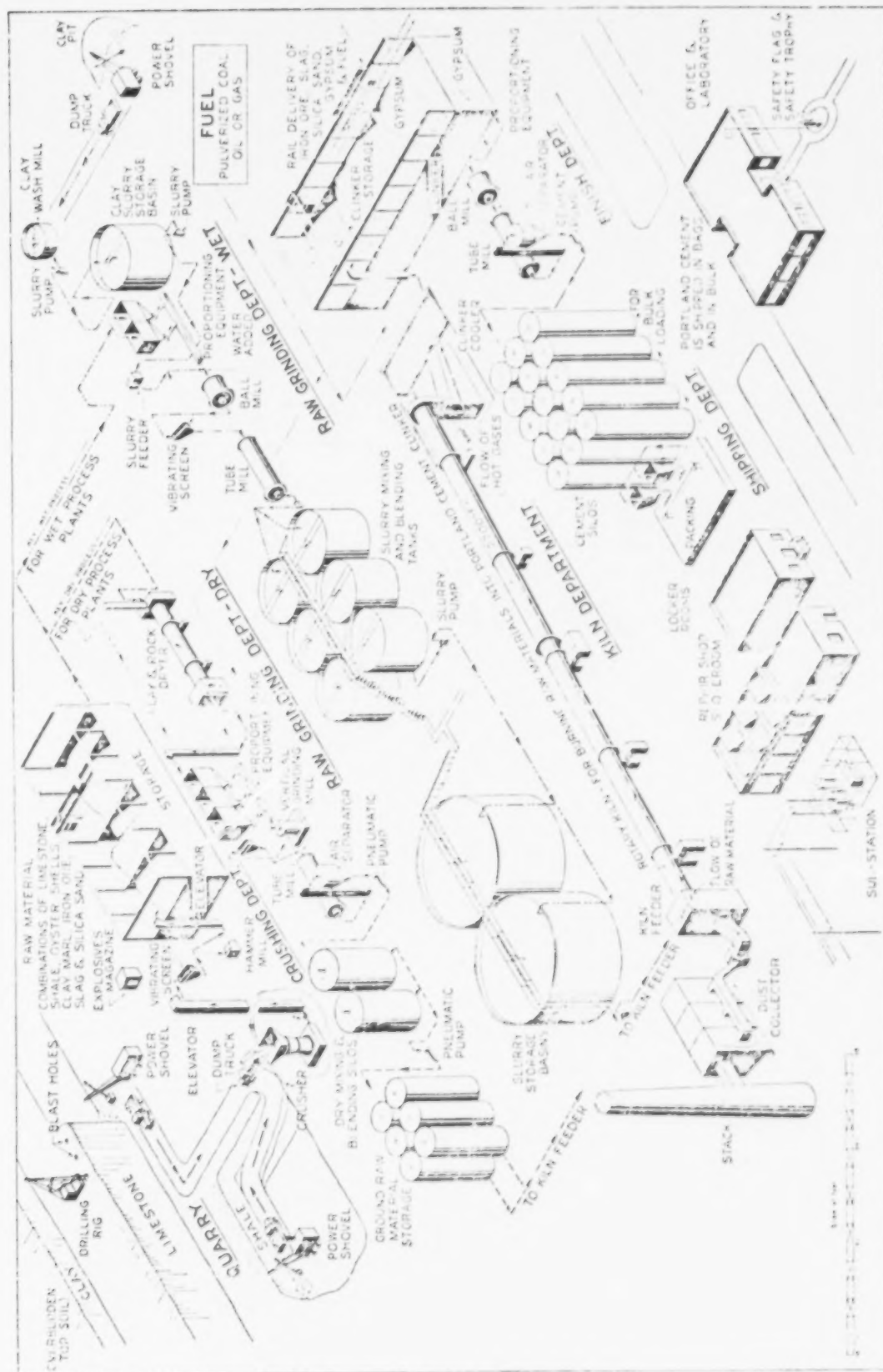
Note: *Per Table 4

Appendix 3

ISOMETRIC FLOW CHART OF
THE MANUFACTURE OF PORTLAND CEMENT

Preceding page blank

ISOMETRIC FLOW CHART OF THE MANUFACTURE OF PORTLAND CEMENT



Source: Portland Cement Association

Appendix 4

ANALYSIS OF CAPITAL NEEDS AND RESOURCES, 1971-1980

SUMMARY

This appendix outlines our derivation of cement industry capital needs and resources for 1971-1980. We have divided the period into halves, 1971-1975 and 1976-1980, to determine whether plant closings resulting from pollution controls by 1975 would create unmanageable cash needs.

Several exhibits are needed to cover the range of variations. In Section 4, we developed two demand forecasts, called "low" and "high". Exhibits A.1 and A.2 translate those demand forecasts into 1975 and 1980 capacity needs, assuming three different rates of closing present plants. The cost of rebuilt and entirely new capacity is determined from historical costs, and we add estimated pollution control costs (new and existing plants) to determine industry capital needs.

Exhibits A.3 and A.5 calculate cash generated by the industry, for the same low and high demand levels. Again, the figures are for 1971-1975 and 1976-1980 periods.

Exhibits A.4 and A.6 show the sensitivity of our estimates of cash generation to changes in price, earnings retention, and debt ratio. These are interrelated, so our analysis assumes that the industry will maintain constant financial policies. This means that the cash generated by a higher price is the total increased profit, less a proportional increase in dividends, plus new debt in proportion to the retained additional earnings. Similarly, if dividend payout is reduced, the cash generated is not only the additional retained earnings but a proportionate increase in debt.

EXHIBIT A.1
ESTIMATE OF CEMENT INDUSTRY CAPITAL NEEDS
LOW DEMAND FORECAST

	1975		1975		1975		1980	
	Low Retirements	mm.	Medium Retirements	mm.	High Retirements	mm.	bbbls. \$/bbl. \$ Million	mm.
1. Demand	482							561
2. Required Capacity	566							660
3. Percent of 1971 Capacity Closed:-								
4. Initial Barrels	84		174		254			566
5. Closed Down	39		512		512			47
6. Net Remaining Capacity	473		84		123			519
7. Needed	566		428		389			660
8. To Be Rebuilt, Added and Newly Constructed	93		566		566			141
9. Rebuilt Retirements (47% of Retirements)	18	5.50	39	5.50	58	5.50		22
10. Remaining @ 46%	35	5.50	46	5.50	55	5.50		35
11. Wholly New @ 54%	40	7.00	53	7.00	64	7.00		48
	<u>93</u>	<u>572</u>	<u>138</u>	<u>838</u>	<u>177</u>	<u>1664</u>		<u>141</u>
12. Control Cost (Government figures)	167		149		131			
Total Capital Costs	<u>873</u>		<u>987</u>		<u>1200</u>			<u>3672</u>

EXHIBIT A.2

ESTIMATE OF CEMENT INDUSTRY CAPITAL NEEDS 1971-1980
HIGH DEMAND FORECAST

	1973		1975		1975		1980	
	Low Retirements		Medium Retirements		High Retirements		nan.	
	mm.	\$/bbl. \$ Million	mm.	\$/bbl. \$ Million	mm.	\$/bbl. \$ Million	mm.	\$/bbl. \$ Million
1. Demand	503		503		503		608	
2. Required Capacity	591		591		591		715	
3. Percent of 1971 Capacity Close-								
down	8%		17%		25%		-	
4. Initial Barrels	512		512		512		591	
5. Closed down	39		84		123		47	
6. Net Remaining Capacity	473		428		389		544	
7. Needed	591		591		591		715	
8. To Be Rebuilt, Added and Newly Constructed	118		163		202		171	
9. Rebuilt Retirements (47% of Retirements)	18	5.50	39	5.50	58	5.50	22	5.50
10. Remaining @ 45%	46	5.50	57	5.50	66	5.50	69	5.50
11. Wholly new @ 54%	54	7.00	67	7.00	78	7.00	80	7.00
	118		163		202		171	
12. Control Cost (Government figure)	167		142		131		-	
Total Capital Costs	589		514		515		515	

1-65

EXHIBIT A.3

INDUSTRY CASH AVAILABLE--LOW DEMAND
(\$ Million)

	1971	1972	1973	1974	1975	Total	1976	1977	1978	1979	1980	Total
1. Sales mm. bbbls.	406	422	440	460	482	2210	496	512	528	544	561	2641
2. Price/bbl.						\$ 3.49						\$ 3.49
3. Total Sales						\$7713						\$9217
4. Return on Sales						6%						6%
5. Profit After Tax						463						553
6. Less Payout @ 59% of P.A.T.						273						326
7. Retained Earnings						190						227
8. Supported Debt (.39:1 D/E ratio)						74						88
9. Total Addition to Capitalization before Depreciation						\$264						\$315

Depreciation Charges

	Low	Medium	High
10. Retirement Level			
11. Current Equipment (1971)	\$540	\$540	\$540
12. Equipment Purchased (1971-1975)	92	123	150
13. Equipment Purchased (1976-1980)	-	-	-
14. Total Depreciation	632	663	690
15. Available from Earnings and Debt	264	264	264
16. Total Cash Available	896	927	954
17. Indicated Cash Needs (Exhibit A 4.1)	739	987	1200
18. Estimated Capital Surplus (Shortage)	\$157	(\$ 60)	(\$246)

EXHIBIT A.4

SENSITIVITY ANALYSIS:
CASH NEEDS AND AVAILABILITY 1971-1975
(\$ Million)

Change in Cash Available 1971-1975

A. Raise ROS 1 percent (3.5 c/bbl.)

1. Additional Profit (1 percent of \$7,713)	\$ 77
2. Payout (59 percent)	45
3. Increase in Retained Earnings	32
4. Additional Debt (@ .39:1)	13
5. Additional Available Capital (1971-1975)	<u>\$ 45</u>

B. Raise Retention by 10 percent

6. Additional Earnings Retained (10% of \$463)	\$ 46
7. Additional Debt Supported by Extra Retention (@ .39:1)	18
8. Additional Available Capital (1971-1975)	<u>\$ 64</u>

C. Raise Marginal Debt/Equity by 10 Percentage Points

9. Additional Debt Supported by New Retained Earnings (10% of \$190)	<u>\$ 19</u>
--	--------------

D. Combination of all three

Raise ROS 1%	
10. Total Profit (@7 percent ROS)	\$540
Reduce Payout 10 percent	
11. Payout (@ 49 percent)	264
12. Retained Earnings	276
Raise Marginal debt/equity 10 percent	
13. Supported Debt (@ .49:1)	135
14. Total Capital Available	<u>\$411</u>

Additional Cash Available	Exhibit A.3 Line Reference
\$ 77	3
9	
86	
61	8
<u>\$147</u>	

EXHIBIT A.5

INDUSTRY CASH AVAILABLE--HIGH DEMAND ESTIMATE
(\$ Million)

	1971	1972	1973	1974	1975	Total	1976	1977	1978	1979	1980	Total
1. Sales mm. bbls.	411	434	455	480	503	\$2,283	521	541	562	583	603	2810
2. Price/bbl.						3.49						3.49
3. Total Sales						\$7,967						\$9806
4. Return on Sales						6%						588
5. Profit After Tax						478						
6. Less Payout @ 59% of P.A.T.						282						347
7. Retained Earnings						196						241
8. Supported Debt (.39:1 D/E ratio)						76						94
9. Total Addition to Capitalization before Depreciation						\$ 272						\$ 337

Depreciation Charges

	Low	Medium	High
10. Retirement Level	\$540	\$540	\$540
11. Current Equipment (1971)	112	143	170
12. Equipment Purchased (1971-1975)	-	-	-
13. Equipment Purchased (1976-1980)	652	683	710
14. Total Depreciation	272	272	272
15. Available from Earnings and Debt	924	955	982
16. Total Capital Available	897	1146	1359
17. Indicated Cash Needs (Exhibit A 4.2)	\$ 27	(\$191)	(\$377)
18. Estimated Capital Surplus (Shortage)		\$ 134	\$ 250

EXHIBIT A.6

SENSITIVITY ANALYSIS:
CASH NEEDS AND AVAILABILITY 1971-1975
(\$ Million)

Change in Cash Available 1971-1975

A. Raise ROS 1 percent (3.5 ¢/bbl.)

1. Additional Profit (1 percent of \$7,967)	\$ 80
2. Payout (59 percent)	47
3. Increase in Returned Earnings	33
4. Additional Debt (@ .39:1)	13
5. Additional Available Capital (1971-1975)	<u>\$ 46</u>

B. Raise Retention by 10 percent

6. Additional Earnings Retained (10 percent of \$478)	\$ 48
7. Additional Debt Supported by Extra Retention (@ .39:1)	19
8. Additional Available Capital (1971-1975)	<u>\$ 67</u>

C. Raise Debt/Equity by 10 Percentage Points

9. Additional Debt Supported by Original Earnings (10% of \$196)	\$ 20
--	-------

D. Combination of All Three

	Additional Cash Available	Exhibit A.5 Line Reference
10. Total Profit @ 7 percent ROS	\$558	3
Raise ROS 1%		
Reduce Payout 10 percent	273	
11. Payout @ 49 percent	285	
12. Retained Earnings	140	
Raise Marginal Debt/Equity 10 percent	140	8
13. Supported Debt (@ .49:1)	<u>\$425</u>	
14. Total Capital Available	<u>\$425</u>	

ASSUMPTIONS

A large number of assumptions and subsidiary calculations are needed for this analysis. Each line of Exhibits A.1-A.6 is numbered to correspond with the explanations given below.

Exhibits A.1, A.2

Line

1. Demand forecasts from Section 4.
2. Industry operating rate of 85 percent, above historic levels due to more efficient utilization of new plants.
3. Data from industry indicates that about one-third of all plant capacity is old (pre-1960) and small (below four million barrels). This is the type of plant most likely to close by 1975. They represent 165 million barrels of capacity. We assume three possible levels of closing: 25, 50, and 75 percent, corresponding to closing 8, 17, and 25 percent of 1971 capacity by 1975.
4. Estimated capacity at end of 1971 is 512 million barrels. This includes imports as an adjunct to U.S. capacity. Estimated 1971 imports are 17 million barrels.
5. Calculated percent closed x 1971 small, old capacity. For 1976-1980, assume closing all plants which become 25 years old during that period, i.e., plants built 1950-1955. Net change 1950-1955 was 47 million barrels, probably slightly less than gross construction.
6. Calculated, line 4 less line 5.
7. From line 2.
8. Calculated, line 7 less line 6.
9. Of the plants closed, 39 percent of capacity will be replaced with new plants 1.2 times as large on existing site. (Actual experience 1967-1971.) This means replacements equal to 47 percent

(=39 percent x 1.2) of retired capacity. Cost of \$5.50/barrel based on interview data and historic cost figures.

10/11. Assumes no change in 1967-1971 mix of new capacity vs. expansions, 46:54 percent. This creates the largest cash needs, since we expect a steady decline in totally new plants, which are more costly than expansions.

A typical calculation of the mix between rebuilt-expanded-new plants, based on a 1000 barrel index and our highest rate of plant closings, is as follows:

	<u>Barrels</u>	
Initial Capacity	1000	
Retired @ 25%	<u>250</u>	
Remaining	750	
Plant Needed in Five Years	<u>1216</u>	(40% demand growth)
Construction Required	<u>466</u>	

Provided by:

Rebuilding (47% x retirements)	118
Expansion	188
New Plants	<u>160</u>
Total Construction	<u>466</u>

160:188 are in assumed ratio of 46:54.

Costs of \$5.50/barrel for expansion and \$7.00/barrel for new plant based on interview data and historic costs. Some industry and supplier spokesmen feel future costs may be \$1.00/barrel higher. That would add \$100-200 million to our estimates of five year spending.

12. Based on E.P.A. cost figures for new and existing plants, to meet all pollution control regulations by 1975.

The Environmental Protection Agency has provided the cement industry with figures on the incremental costs to meet the new standards. These figures consider only those expenses over and above amounts necessary to meet already existing regulations, health and safety standards, and community objections. This interpretation differs from that of the industry which considers all pollution control costs together. This analysis utilizes the E.P.A. figures as required by the terms of the study. The E.P.A. figures total \$96 million capital cost over the five year period ending in 1976. This applies to the total industry capacity in place in 1971. According to the E.P.A. standards draft, no control cost is attributed to plants constructed after 1967.

In the analysis assumptions were made about the amount of plant which will be closed rather than upgraded to achieve satisfactory emission standards. The levels of retirement assumed were 25, 50, and 75 percent of the small, old plant in existence in 1971. This was equal to 8, 17, and 25 percent of all 1971 plant. Of total 1971 industry capacity of 492 million barrels, 428 million barrels were built before 1967. The amounts assumed retired and the control costs allocated to the retired and remaining barrels are as follows:

<u>Retirement Level</u>	<u>Barrels Retired (Millions)</u>	<u>Control Cost Allocated to Retired Barrels (\$ Million)</u>	<u>Expended Control Cost (\$ Million)</u>
Low	39	18	167
Medium	84	36	149
High	123	54	131

Incremental Control Cost

Capital	\$96.6 million
Operating	<u>88.3</u>
Total	<u>\$184.9</u>

Industry capital costs based on information provided by cement producers representing over 70 percent of industry capacity indicated total incremental capital costs of about \$215 million, or \$118 million higher than those provided by the Environmental Protection Agency.

Exhibits A.3, A.5

Line

1. Demand forecasts based on Section 4. Growth rates are:

<u>Demand</u>	<u>1971-1975</u>	<u>1976-1980</u>
Low	4.1%	3.1%
High	5.2	3.8

2. 1970 industry average mill net price (\$3.32), plus 5 percent to allow for closer balance between supply and demand.
3. Calculated, line 1 x line 2.
4. Return on sales based on 1970 average for seven cement companies, one-third of industry capacity. Assume interest charges exactly offset savings from new plant efficiency, a conservative assumption.
5. Calculated, line 3 x line 4.
6. Dividend payout is seven company average.
7. Calculated, line 5 less line 6.
8. Debt/equity ratio is seven company average.
9. Calculated, line 7 plus line 8.
10. Retirement level corresponds to 8, 17, and 25 percent rates used in Exhibits A.1, A.2 (line 3).
11. Extended from seven company total depreciation (\$35.8 million) to total industry based on sales ratio. Industry estimated annual depreciation

is \$108 million x 5 years is \$540 million for 1971-1975. Depreciation 1976-1980 is less due to retirement of pre-1971 capacity during that period.

12/13. Additional depreciation for new capacity depends on level of retirements. Assume retired plant is replaced, on average, in middle of period and depreciated for 2.5 years at 5 percent rate, or 12.5 percent for the period.

LOW DEMAND FORECAST--EXHIBIT A.3
(\$ Million)

	Retirement Level		
	Low	Medium	High
Capital Additions (Exhibit A.1, line 12)	\$739	\$987	\$1200
Total Depreciation	<u>.125</u>	<u>.125</u>	<u>.125</u>
Depreciation Charges 1971-1975	\$ 92	\$123	\$ 150

For 1976-1980 the full five year depreciation is taken, so these charges are doubled.

Equipment purchased 1976-1980 is \$872 million (Exhibit A.1, line 12). Again assuming 12.5 percent depreciation for the period, depreciation charges will be \$109 million.

HIGH DEMAND FORECAST--EXHIBIT A.5
(\$ Million)

	Retirement Level		
	Low	Medium	High
Capital Additions (Exhibit A.2, line 12)	897	1146	1359
Total Depreciation	<u>.125</u>	<u>.125</u>	<u>.125</u>
Depreciation Charges 1971-1975	112	143	170

For 1976-1980 the full five year depreciation is taken, so these charges are doubled.

Equipment purchased 1976-1980 is \$1060 million (Exhibit A.2, line 12). Again assuming 12.5 percent depreciation for the period, depreciation charges will be \$13 million.

- 14. Calculated, line 11 plus line 12 plus line 13.
- 15. From line 9.
- 16. Calculated, line 14 plus line 15.
- 17. From Exhibit A.1 and A.2, line 12.
- 18. Calculated, line 17 less line 18.

Exhibits A.4, A.6

Line

- 1. Sensitivity of capital availability to raising return on sales from 6% to 7%, all else remaining constant.
Calculated, 1% of line 3, Exhibits A.3 and A.5.
- 2. Calculated, 59% of line 1.
- 3. Calculated, line 1 less line 2.
- 4. Calculated, 39% of line 3.
- 5. Calculated, line 3 plus line 4.
- 6. Sensitivity of capital availability of reducing payout from 59% to 49%, all else remaining constant.
Calculated, 10% of line 5, Exhibits A.3 and A.5.
- 7. Calculated, 39% of line 6.
- 8. Calculated, line 6 plus line 7.

9. Sensitivity of capital availability to raising marginal debt/equity rates from .39:1 to .49:1, all else remaining constant.

Calculated, 10% of line 7, Exhibits A.3 and A.5.

10. Sensitivity of capital availability to a combination of the above elements: raising return on sales, reducing payout, and increasing debt/equity ratio.

Calculated 7% of line 3, Exhibits A.3 and A.5.

11. Calculated, 49% of line 10.

12. Calculated, line 10 less line 11.

13. Calculated, 49% of line 12.

14. Calculated, line 12 plus line 13.

Appendix 5

ANALYSIS OF THE ECONOMICS OF A HYPOTHETICAL
NEW CEMENT PLANT

This example shows the economics associated with a hypothetical large new plant of 10 million barrels operating at 85 percent of capacity. Most of the cost figures come from a similar analysis explained in "Cement in the Seventies" by William F. Young, president of Lehigh Portland Cement Company.

The cost of the plant, \$8 per barrel, is derived from past construction costs and discussion with equipment suppliers. The sensitivity of return to plant cost and debt/equity ratio is also shown. The \$8 figure is higher than our estimate of plant construction costs used elsewhere in this report, to give a conservative estimate of potential return.

Hypothetical Investment: 10 million barrel plant

Operating Rate: 85% of capacity

Price/bbl: \$3.32 (1970 average price, mill net)

	<u>\$Million</u>
Cost @ \$8/bbl =	\$80

Working capital @ 11% = 9

Total investment	<u>\$89</u> million
------------------	---------------------

Financing @ 2:1 debt/equity

Debt	\$59 million
------	--------------

Equity	<u>30</u>
	\$89 million

Repayment @ 8% interest rate, 20 years (10.1% capital factor) = \$6.1 million/year

Average payment \$3.1 interest
 \$3.0 principal
 \$6.1

Typical Operating Results

	<u>\$ Million</u>
Revenues @ \$4.30/bbl.	36.5
Freight Costs @ \$0.98/bbl.	8.3
Mill net revenues	<u>28.2</u>
Direct Costs @ \$14.0/bbl.	11.9
Gross Margin	<u>16.3</u>
Fixed Costs (Property tax G&A, Insurance, etc.)	1.7
Depreciation @ 5% x \$80 million	4.0
Depletion @ 15% x 1/3 Direct Cost	0.6
Interest	<u>3.1</u>
Profit before tax	6.9
Taxes @ 50%	<u>3.5</u>
Profit after tax	<u>3.4</u>
Cash Flow	
Profit after tax	3.4
Add-depreciation, depletion	4.5
Less-debt repayment	<u>(3.0)</u>
Net cash flow	<u>4.9</u>

Average return on equity = $4.9/30 = 16.3\%$
 At 1:1 debt/equity, return is 13.8%
 At 2:1 debt/equity, and \$9.00 plant cost, return is 14.1%.

These are average return figures. On a discounted cash flow basis, the use of accelerated depreciation, increasing principal payments, and recovery of working capital

(at least) after 20 years would raise the rate of return substantially. If the plant were operated 25-30 years, but depreciated in 20 years, rate of return would be higher yet.

It seems clear that a large, efficient cement plant is a very attractive investment, when well levered with debt. When levered with industry's typical debt of 0.39:1, the rate of return would be 12% on average, about 14% on DCF basis.

To date no U.S. cement company has constructed a plant this large. The risks in doing so would be considerable because of the possibility of market disruption. On the other hand, there is a plant nearly this large in Ontario, Canada, and one considerably larger in Brussels, Belgium, both operated by the same company. We believe bigger plants to be operating in Japan and the U.S.S.R.

The conclusions of this analysis are likely to be disputed by individuals active in cement industry management. Indeed, it is the disagreement among industry executives as to the potential returns from a new plant which has led to the sharply divergent behavior between companies with respect to new plant construction. This analysis is designed only to show the economic feasibility of a very large plant based on one set of operating cost assumptions. The impact of such a plant on price structure could be severe, depressing the indicated return substantially for some period.